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Janus, the ancient Greek God, had two faces. One looked backward into the past—the other looked forward into the future. In these times, industrial progress is made by those who face the future—and take no step backward.

FOR CENTURIES we have been making progress. Social progress, economic progress, industrial progress. All of this time we have gone forward—not backward.

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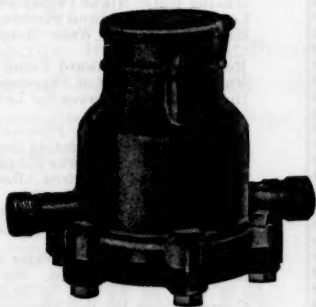
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OF THE

AMERICAN WATER WORKS ASSOCIATION

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Discussion of all papers is invited

Vol. 24 DECEMBER, 1932 No. 12

DISCUSSION

PLAIN END PIPE AND SPECIALS VERSUS BELL AND SPIGOT PIPE AND SOLID SLEEVES

THOMAS J. SKINKER:¹ During the past year the St. Louis Water Division laid 10,000 feet of 36-inch steel pipe and used Dresser couplings for jointing pipes.

In the first 5,000 feet there were some excessive cuts (as much as 16 feet), two double track railroad crossings, several hundred feet through a cinder dump which was back-filled with lime-stone screenings.

On 1,700 feet gas and water services were encountered every 30 feet.

The cost of this job was as follows:

	per foot
Pipe and couplings.....	\$5.95
Castings and Miscellaneous.....	2.52
Labor.....	4.87
Total.....	\$13.34

On the second 5,000 feet there was no excessive digging. No house services or bad soil were encountered. One length thirty feet long was jacked across under a paved street.

¹ Engineer, Water Department, St. Louis, Mo.

The cost of this installation was as follows:

	<i>per foot</i>
Pipe and couplings.....	\$5.75
Castings and Miscellaneous.....	1.29
Labor.....	2.60
Total.....	\$9.60

This makes an average of \$11.495 per foot for the ten thousand feet.

The cost of laying this line using cast iron is estimated at \$18.00 per foot. This is a saving of \$65,000.00.

All curves, tees, blow-offs and valves used were bell and spigot and made of cast iron. Wherever cast iron was used a band consisting of a copper plate welded to the steel pipe at each side of the cast iron with a #4/0 copper wire connecting the two plates was used. In order to make the joint where steel pipe was shipped into the cast iron bell a band 8 inches wide and 1-inch thick was welded onto the end of the steel pipe to give the steel pipe the same outside diameter as the cast iron.

This was my first experience with plain end pipe and couplings and I have been greatly impressed with the saving made and the ease with which this line was put together.

I believe that plain end pipe and a good coupling have many advantages over the bell and spigot pipe with poured joints.

The American Gas Association has made exhaustive studies of the various types of joints and I am giving here their summary and recommendations which, I believe, we may profit by studying. These are taken from "The Report of Subcommittee on Pipe Joints" of which H. W. Battin was Chairman and which was submitted at their 1931 Convention.

"Repair of Old Joints. It is felt that leak clamps offer the most practical and advisable means for the permanent repair of leaking cast-iron bell and spigot joints up to and including 16-inch in size. For the most successful performance their design should provide for the following:

"(1) Ample cross-sectional area of the gasket. The width should be substantially greater than the width of the joint space.

"(2) The segments of either of the clamp rings should be of such design as to afford ample rigidity and also be as few in number as possible. Means should be furnished to provide a secure and substantial method of locking the individual segments to form substan-

tially a solid ring when finally assembled. Such construction is essential to prevent excessive distortion of the clamp ring which would result in a release of compression on the gasket. This is of particular importance in larger size clamps.

"(3) It is important that careful consideration be given to the dimensions of the bell to which a clamp is to be applied. Clamps are available to fit the majority of bells usually encountered in service. Care should be taken that a clamp of the proper dimensions is selected.

"In preparing a joint to receive a clamp, care should be taken that the following conditions are observed:

"(1) The surfaces of the joint and the adjacent metal should be thoroughly cleaned.

"(2) When lead joints are used recaulking may be resorted to in order to face up the joint surface as nearly as possible flush with the bell. If the lead is recessed more than $\frac{1}{8}$ inch after recaulking, it is advisable to cut out the lead to a depth of at least $\frac{1}{8}$ inch. Either cast lead or lead wool, properly caulked, may then be used to reface the joint flush with the bell face. If so desired, the joint may be refaced with cement after cutting out not more than $\frac{1}{8}$ inch of the top lead, using the method given below for cement joints.

"(3) For cement joints the top cement may be cut out to a depth of not more than $\frac{1}{8}$ inch and the joint refaced with neat cement. Care must be taken to finish off the cement smoothly. The clamp may be applied immediately to the green cement.

"(4) A thin coat of gasket compound or similar lubricant should be applied to the area to be covered by the gasket and also to the joint of the gasket. Where a joint has been refaced with cement the use of the compound is unnecessary except on the joint of the gasket."

Generally speaking it is considered that rubber gaskets are to be preferred to those of the duck tipped type.

New joints. "The following recommendations for new construction are made, based on the results of tests on 4- and 16- inch joints.

"In considering these recommendations on new joints it must be remembered that the test conditions were probably more severe than normally occur in actual practice, distortion being greater and more violent, and that the test gas was a clean dry gas, namely, air. The record of leakage on thousands of miles of bell and spigot pipe made up with cast lead or cement or lead wool or a combination of these materials with yarn cannot be refuted. This record, however, was

established under conditions of manufactured gas, saturated and super-saturated with water, oil, naphthalene, etc., the deposition of which in the mains aided materially in the closing up of joint leaks if and when they occurred. Also, pressures in the past have been lower than they now are. As B.t.u. standards were lowered for greater economy, less oil was deposited in the mains; then came change-overs from manufactured gas to bone dry, moisture hungry, natural gas. This gas produced the reverse effect of manufactured gas drying out the joints, with ensuing increase in leakage. It is for this worst condition of bone dry, moisture hungry gas that the following recommendations are made.

"(1) Cement joints are not recommended for pressures much in excess of 10-inch of water and should be restricted as far as possible to the smaller sizes. No. 1 A.G.A. standard bells should be used. No. 2 or "B" bells are not recommended.

"Cement is not suitable for joints as large as 16-inch. The joint material in this size is relatively so weak in respect to the pipe as to be unable to withstand the action of external forces tending to deform it.

"(2) Cast lead joints are not considered satisfactory for new construction even for low pressures. Lead offers little resistance to deformation and is unable to return to its original position when once deformed. Lead joints are thus likely to leak readily.

"(3) Lead wool joints, while superior to cast lead are quite expensive to prepare and it is doubtful whether they can be depended upon to stand up in service. The inherent objection to the use of cast lead applies also to a certain extent to lead wool but may be overcome partly by more effective caulking such as obtained when air tools are used. The workmanship is of great importance in preparing such joints.

"(4) The use of two concentric rubber rings with inclined faces in contact and held in place by cement is recommended for joints up to and including 16 inches in size, for pressure above $\frac{1}{2}$ pound. Such joints have been found tight under severe test conditions at 50 pounds pressure. Their use is recommended for working pressure up to 25 pounds.

"(5) Mechanical joints such as the Anthony, Dresser and Double Simplex all of which make use of rubber rings as gaskets, are recommended for use with cast-iron mains for pressures above 25 pounds. These have been tested out and found tight at pressures up to 150

pounds under conditions even more rigid than those used for bell and spigot joints."

H. P. BONCHER (Dresser Manufacturing Company, Bradford, Pa.): As a representative of the company which manufactured the coupling mentioned and discussed in the paper just presented by Mr. Skinker, I should like to say a few words about the longevity of the component parts of this coupling, with special reference to the gaskets used, which seems to be of particular interest here. The followers, middle ring, and bolts of the style of coupling referred to are made of steel, which is approximately of the same chemical composition as steel pipe.

Gaskets used in this type of coupling are made of specially compounded rubber, which is the result of a development extending over a period of many years. It is not ordinary rubber. In our exhibit at this convention we have on display two gaskets which were removed last week from a water line in the city of Bradford after having been in continuous service since 1910. With the exception of a thin, hard coating on the outside of these gaskets, they show no signs of deterioration. They are just as resilient as when they were first installed and would undoubtedly have given satisfactory service indefinitely. These gaskets happen to have been installed in a coupling made up of a cast iron middle ring, cast iron followers, and steel bolts. Incidentally, these metal parts, which are also on exhibit at our booth, are in an excellent state of preservation, showing practically no signs of corrosion.

When considering the life of a coupling gasket of the type mentioned it should not be compared with the life of an exposed and unconfined piece of ordinary rubber. The design of the coupling is such that these specially compounded gaskets are almost completely confined under very high pressure. Those who visit our booth may see an actual cross-section of a coupling assembled on a piece of pipe, showing just how little of the gasket is unconfined.

Rubber manufacturers tell us that the natural enemies of rubber are heat, light, and lack of moisture. Couplings installed on a water line, particularly when they are underground, are operating under conditions that tend to preserve the life of the gasket, namely, dampness, darkness, and low temperatures. With these ideal conditions of service, plus the fact that the coupling gasket is under compression and almost completely confined, which in turn is further protection

against oxidation and aging, we feel that these gaskets, assembled in couplings of this type, can be depended upon indefinitely. Our experience verifies this opinion. Our customers frequently send us coupling gaskets that have been in service for a number of years and invariably we find them in excellent condition.

While these statements are true in regard to coupling gaskets on water lines, in the case of gasoline, oil, or manufactured gas lines, we furnish gaskets of the same rubber compound but of a special construction, or gaskets of a different compound developed for the particular service involved. Mr. Skinker mentioned a duck tipped gasket in connection with his reference to clamps. This is a type of special construction used in some services other than water lines.

T. A. LEISEN (Omaha, Neb.): I did not come prepared to discuss this paper. In fact I had not thought of discussing it, but there are a few points that came up that might possibly be of interest, especially if it will bring out further discussion. We have been using Dresser couplings in Omaha for gas lines. We happen to have both the gas and water under our control, but have not used Dresser couplings on the water lines.

We have in contemplation at the present time several thousand feet of 6-, 8- and 12-inch pipe to be installed in the near future. These are for what will eventually, if not now, be high pressure lines and our gas engineers are insisting on something better than the ordinary lead joints. In other words, they want the Dresser coupling, or something equivalent to it. The question then comes up in our mind whether there is any material difference between a joint such as the Double X Simplex, the Anthony Joint, and the Dresser Coupling. All these types of joints use a rubber gasket and in our case we would probably insist on the lead tipped gasket, because when we subjected the joint for sometime, at least, to manufactured gas the lead tip is better.

In making estimates as to the relative cost I find that by using the cast iron pipe, either the straight cast, or the bell-void type, or the monocast, with the type such as the Double X, Simplex type, I find that the cost would be approximately about \$1.44 less per length than using a plain end pipe and the Dresser coupling. On the 8-inch it would be about \$1.97 and on the 12-inch it would be about \$3.44 less.

One objection which has been raised by our engineers to the single type of joints, where the bell is cast on the pipe and only one rubber

gasket used on one side, is that the amount of joint movement, due to expansion of the pipeline would be double what it would be with the Dresser coupling which has the two sets of rings. The thought is that, if there is sufficient movement of the pipe back and forth to break the original contact between the rubber joint and the outer shell of the pipe it may result in leakage. Frankly, I do not know what the result will be in that case and if there is any information that can be gleaned from this meeting I certainly would like to have it.

I might say that with the Dresser coupling gas lines that we have laid in recent years, they have been absolutely tight. This is not a gas convention, but as long as the question was brought up as to the relative merits of the joint for gas lines I thought it might be of interest if anything further could be brought out as to the relative merits of the two types of joints and whether the difference in cost is warranted.

MR. SKINKER: You are handling both the gas and water?

MR. LEISEN: Yes.

MR. SKINKER: Do you not find it much easier to make a joint hold on water than you do on gas?

MR. LEISEN: Undoubtedly, yes.

MR. SKINKER: That was the reason that I made this statement in the paper in an AGA Association Report, because I felt that those tests were very much more severe, the joint was much harder to hold than if it had been used with the water.

MR. LEISEN: There is no question on that point. Gas will leak out through very minute openings, and there is nothing in the gas, particularly in natural gas, to which Mr. Skinker referred, to fill up the voids which may exist in the jointing material. Manufactured gas has enough moisture and oil in the pipes to overcome that difficulty to some extent. I think the point is clearly shown in connection with some of these various types of material used as a substitute for lead, leadite, etc. Even if such joints are not absolutely tight at first on the water line they soon become tight by reason of the filling up of the voids that may exist and possibly the water has some effect

on the jointing material itself, so that after a short time they are ordinarily absolutely water-tight. It will not work on gas at all. Portland cement joints to some extent, act the same. If the cement is tight at first, and it can be made tight, it may be all right, but if there happens to be any movement of pipe and the least breakage occurs in that joint, gas will leak out and continue leaking, usually getting worse as time goes on. The result of gas leaking on streets where there happens to be any trees is particularly bad. The killing of a fine tree in front of a piece of property, will probably cause more trouble than any leaking of water into the cellar would do.

MR. BONCHER: I should like to add a few words in answer to the questions in regard to the coupling middle ring and bolts. The coupling mentioned in Mr. Skinner's paper is of steel construction for use on steel pipe and is supplied with metal parts that are comparable in thickness and strength to the pipe on which the coupling is used. For cast iron lines our company manufactures a coupling of the same type and design made of high tensile cast iron, equipped with cadmium plated or galvanized bolts.

With reference to the service required from a bolt in a coupling of this type I would like to mention a recent experience we had in our testing laboratory. Our engineers set up an 8-inch coupling on a short length of test pipe and after making the desired test, wished to remove the gaskets without injuring them. They decided to remove the flanges and bolts and apply internal hydrostatic pressure; they found that it was necessary to apply a pressure in excess of 500 pounds per square inch to force the rubber out of the recess. These remarkable results were obtained in spite of the fact that the coupling had been assembled less than twenty-four hours. To remove the bolts after the coupling has been installed would be an absurdity, but this experience is nevertheless significant and should be of interest to any of you who have been thinking along this line.

In cases where the coupling has been in service several years or more, the gaskets just seem to freeze on to the pipe and the coupling parts with which they are in contact so that when a line is dismantled, the gaskets alone will tend to hold it together. Men in the gas industry who have used a great many of these couplings on high pressure lines, will bear me out in the statement that when, as frequently happens, they take up lines on which couplings of this type have been in service for many years, they experience great difficulty in disman-

ting them due to the tendency of the gaskets to freeze to the metal parts.

USE OF NON-FERROUS SERVICE PIPES AT PRESENT PRICES

GEORGE W. PRACY:¹ The consideration of the advantage of any material for use in service pipe opens a wide range of discussion, for no one metal can be said to be the best under all conditions. Price and other conditions affect the choice. In the beginning lead was the chosen metal, then came iron, then steel, then the lined steels, lead lined and cement lined and now copper and brass.

The composition of the ground largely controls the material that can be used. If the entire length of the ditch is to be dug any metal can be laid; if the pipe is to be driven, as is usually the case with us, a pipe sufficiently stiff and rigid must be selected. In at least one city services are laid of 2-inch cast iron pipe, the service being laid on every other lot and used to supply both premises. Perhaps all of these methods have their place.

With this introduction let us turn to specific cases in San Francisco. Here the soil is over half pure beach sand and about seventy per cent is pure sand, or a light sandy soil. The other thirty per cent is heavy soil; clay and rock. In the seventy per cent of light soils the pipe can be driven under the pavement; in the thirty per cent of heavy soils it cannot. This plays a large part in our choice of materials. With an average service length of 20 feet the cost of cutting and replacing the pavement would amount to twelve dollars. If the pipe is driven only about five feet of pavement need be removed. Assuming a unit cost of removing of 15 cents per square foot as against 10 cents in the larger jobs, the total cost would be but \$3.75.

The material costs are easily compiled and vary somewhat from place to place and more so from time to time. They are given in table 1.

The labor charges are more uncertain. They vary widely. After going over our records and some detailed costs I have selected a figure of \$5 as being the labor cost of the average $\frac{3}{4}$ -inch service and I have used it for all jobs. Each of you can substitute the figure that more nearly represents your conditions. Now again applying these specifically to San Francisco. In 1927 we made an examination of all material that gave trouble that year. The leaking piece was cut

¹ President, The American Water Works Association; Superintendent, Water Department, San Francisco, Calif.

out properly labeled and sent to my office. I inspected each piece, listing the causes, age and soil conditions. Thirty per cent of the pieces examined came from the 70 percent of light soils, while 70 percent came from the 30 percent of heavy soils, a ratio of almost $5\frac{1}{2}$ to 1. A large proportion of the leaks came in the threads, where the galvanizing had been entirely cut away and the metal thickness greatly reduced. It so happens that in the 70 percent of light soil, where the least corrosion occurs, we can drive the pipe, and in the 30 percent of heavy soils, that are harmful we cannot drive the pipe. The logical thing for us to do then was to continue to use galvanized steel in

TABLE 1
Comparative cost for various metals in services

	GAL- VAN- IZED STEEL	AA. LEAD	B LEAD	COPPER TUBE	COPPER I. P. S.	BRASS I. P. S.
1. Screw taps and tail piece.....		0.66	0.66	0.66		
2. Lead connections complete.....	1.24				1.24	1.24
3. Pipe.....	1.20	5.64	3.62	1.61	3.70	3.47
4. Fittings.....	0.09				0.24	0.24
5. Nipples.....	0.18				0.50	0.45
6. Curb cock.....	0.26	0.66	0.66	0.66	0.26	0.26
7. Total material.....	2.97	6.96	4.84	3.85	7.54	6.79
8. Labor.....	5.00	5.00	5.00	5.00	5.00	5.00
9. Cartage.....	0.50	0.50	0.50	0.50	0.50	0.50
10. Paving.....	3.75	12.00	12.00	12.00	3.75	3.75
Total cost, dollars per foot....	12.22	24.46	22.44	20.43	15.19	14.91

the light soils and to use copper tubing in those soils where we must of necessity break the pavement and dig the entire ditch.

The preceding has been for the general run of services under paving. Where no paving is encountered table 2 shows comparable costs. These costs are based on actual work done in Mt. Vernon park, a small subdivision in San Francisco. The costs are altered to conform to present prices. Here the copper tubing is the cheapest. If no lead connections were used on the iron pipe the costs would be slightly in favor of the steel.

The total cost of service connection repairs averages \$55,000 per year. About \$35,000 of this is due to deterioration of the metal, both lead and steel. We now have 110,000 services in use besides

several thousand that have been taken out of service. Assuming that one half of these were put in after the street was paved, the total investment would be about \$450,000 additional. At 7 percent this would amount to \$31,500 per year. To this would have to be added some additional depreciation or obsolescence on the greater cost.

In San Francisco, for the present at least, we have solved our problem by using copper wherever we get into the heavier soils and cannot drive and using galvanized steel in the lighter soils where we can drive underneath the pavement.

TABLE 2

Cost of services—Mt. Vernon Park, sandy clay soil, no paving

Average length of service, 23 $\frac{3}{4}$ feet

	GAL- VAN- IZED STEEL	AA LEAD	B LEAD	COPPER TUBE	COPPER I. P. S.	BRASS I. P. S.
Material pipe.....	1.40	5.64	3.62	1.61	3.70	3.47
Lead connection.....	1.24				1.24	1.24
Screw tap.....		0.66	0.66	0.66		
Curb cock.....	0.26	0.66	0.66	0.66	0.26	0.26
Fittings.....	0.09				0.24	0.24
Nipples.....	0.18				0.50	0.45
Total materials.....	3.17	6.96	4.94	2.93	5.94	5.66
Labor.....	4.21	4.21	4.21	4.21	4.21	4.21
Cartage.....	0.02	0.02	0.02	0.02	0.02	0.02
Paving.....						
Total cost, dollars per foot.....	7.40	11.19	9.17	7.16	10.17	9.89

J. E. GIBSON (Charleston, S. C.): The first thing I want to say as Chairman of the Committee, 7F, on Water Works Practice, Service Connections, and Brass Goods, for Underground Services Work, is that this paper is very interesting, indeed, and comes at a very opportune time. I feel the same as Mr. Pracy that there is no one material that can be universally adopted throughout America. I think, however, that the copper tubing, and the copper pipe, iron pipe size, or brass pipe, iron pipe size, are probably, with the present prices of that material, coming to be more and more adopted over either galvanized or steel pipe, or over lead pipe.

Speaking from our experience at Charleston we cannot use the

galvanized iron or steel pipe at all. Our water is an aggressive water and our soil is more or less corrosive. Our average elevation is only a few feet above mean tide. Lots of our ground is of organic soil, that is, it is very corrosive and we have had standard weight galvanized, iron or steel pipe pit through from the outside in less than two years. We use almost exclusively, or have up to the last eighteen months, AA lead pipe. We have no trouble with it if properly laid.

We have in the last eighteen months been experimenting more or less with copper tubing and we are experiencing very good results with that covering the period that we have had it in use. I do not understand, however, why Mr. Pracy cannot put in copper tubing by pushing or boring under the pavement. We put lead in that way by simply driving through a steel pipe and attaching our lead to the opposite end of it and then pulling the pipe back, letting the lead pipe follow the steel pipe through by a tension, rather than by compression. We have done a little bit of the copper tubing in the same way with very satisfactory results. I am surprised, however, at the low cost of replacing pavement in San Francisco.

Our minimum charge in Charleston is five dollars. That is supposed to cover one square yard of paving. If it is an 18-inch hole why we pay for a square yard, but many times where we have to push a pipe through the street and strike a piece of sheathing or a wale that has been left in by the sewer contractor, and have to cut open the street a second time our paving charges are often in excess of the actual cost of labor and material of laying the service pipe and we have rather narrow streets. I know San Francisco has some pretty wide streets.

I believe that you cannot afford to look at the first cost in this day of modern street improvement and the desire of the public to ride on rubber easily and softly, because of the cost of replacement and the tearing up of paved streets, and the complaint on the part of the public is too great. It pays to put in the best material for your particular locality. I am not so certain about whether the copper tubing or the iron pipe size copper, or brass pipe, will win out in the end.

MR. PRACY: May I just say, to make myself clear, that we can drive steel pipe and put copper tubing or lead pipe through. It is just a matter of general conditions and general opinion, I guess. For twenty years we used nothing but steel pipe. We had no real trouble with it, nor are we having any real trouble with it today.

Now to draw, or force, the copper pipe under the street, in our opinion, would cost us more than it is worth. That is all. We have such good success with the steel pipe we use that, particularly in the lighter soils that we have we do not think that the other way is worth the trouble. As far as paving is concerned our average service is just 20 feet long. We cut a ditch a foot wide, which gives us 20 square feet.

The cutting and replacing of that ditch costs us 50 cents a square foot. We have an ordinance in our city that requires that we put black base pavement back in all of our service ditches so that we want to put the concrete paving back, but we cannot do it. We have to put the black base back right away. That is more expensive at any rate, for it costs us 50 cents a square foot, and on the average of 20 square feet that is 10 dollars. We have found that our over-breakage runs about 20 percent, that is for every 10 square feet that we break up we put back 12 square feet, at least. We pay for putting back 12 square feet, which makes our total average paving job on a paved surface 12 dollars.

CHAIRMAN PORZELIUS: How deep do you bury your service?

MR. PRACY: That is another question that is very appropriate. We put our services, theoretically, two feet deep. Actually I am not so sure they always go that deep. But we are fortunate in that we have no cold weather troubles out there. We can lay our services on top of the ground if we want to, but we actually put them down two feet.

S. B. MORRIS (Pasadena, Calif.): I might, without giving the cost, tell you how it works out with us in Pasadena. On new streets where we are laying ahead of paving we generally lay 2-inch cast iron services, the same as Los Angeles does, one service to supply two lots, or if the area is unsubdivided one service to every 100 feet of frontage on each side of the street. In wide streets we lay two mains if there are street car tracks down the center, or the streets are very wide, we lay a line at either side and use copper services altogether for the shorter services between the main and the meter. For the average run of services around town that do not fall into those classifications we use a steel or wrought iron service where we drive the service pipe, and we use copper where we can economically dig out the full service length.

With us the soil changes are so rapid that you cannot tell until the service is actually dug out, what soil conditions you are going to find in different areas of the city. We have not made quite as substantial a saving in driving our services under paving as we might, owing to a number of substantial losses through errors which we have made in hitting telephone cables. We got one bill for \$1500 for driving into a telephone cable and we have had other bills for lesser amounts and that has wiped out some of our profits for driving under the pavement. We try to caution our men on all the streets that have telephone, or power cables in them to use great care. If they strike them at any time it is always an expensive job.

H. F. BLOMQUIST (Cedar Rapids, Ia.): Where 2-inch surfaces are laid to two lots, what type of connections are made between the main and the 2-inch cast iron services?

MR. MORRIS: We tap the main with a corporation cock having a double male corporation cock and screw on it a bell end fitting with prepared lead joint and caulk it. This makes a direct connection between the 2-inch pipe and the main. We have had no trouble with these at all. I am using that type altogether.

T. H. WIGGIN (New York, N. Y.): Speaking to the question of the brittleness of copper pipe: there are about a hundred water companies with which I have to do and probably three-quarters of them are using copper pipe. One of the lot has reported trouble with brittleness and that case has been somewhat investigated, although I am not sure that we have the complete answer as yet.

The explanation was that it had been the practice of the foreman to take out a 60 feet coil of copper pipe, uncoil it and cut off what was wanted and then coil the remainder and put it back in his truck for future use. At the end of a number of coilings and uncoilings the copper pipe had become brittle. There seems to be no doubt that such coiling and uncoiling does increase the stiffness of copper pipe very considerably. The fact that out of sixty odd companies, or more, only one has reported trouble gives reason for thinking that something of the sort must have occurred rather than that any difficulty was inherent in the material.

I wanted to ask Mr. Pracy what was the limitation on the life of his galvanized iron or steel pipe? Is the corrosion from the outside or from the inside, or is the limitation in reduced carrying capacity?

MR. PRACY: I do not remember the exact figures, but I would say that about 80 percent of it came where the galvanizing had been cut away at the threads. Pipe cannot be screwed into a fitting to cover up all of the treads and 80 percent of our trouble came where the threads were exposed; the other 20 percent was on the outside of the pipe. There was none on the inside whatsoever. I cannot describe the effect on the outside in any other way than to say that it was just general deterioration of the metal.

MR. WIGGIN: I think in the East we are more likely to be troubled with interior corrosion and loss of capacity. I have just had the misfortune to have that trouble in my own house. I had to abandon a hundred feet of 1-inch galvanized steel pipe, 24 years old, because it ceased to deliver sufficient water, although the street pressure is over 60 pounds and the 1-inch size is unusually liberal for my moderate-sized, detached 3-story house. The outside of the service pipe is in good condition.

I had also to abandon some interior cold and hot water pipe, supposedly brass, because the plumber, in the interest of personal profit, had used galvanized fittings every now and then in the brass lines. Where inspected each end of these iron fittings had a beautiful ring of rust, practically a diaphragm with only about $\frac{1}{8}$ -inch diameter hole, that did not permit much water to come through. Galvanic action between the brass pipe and the iron fitting was clearly indicated. If I had been able to take out those offending iron fittings from the line, I probably would have gotten along for another 20 years, but as I did not know where they were I had to abandon the whole thing. At one place a length of iron pipe had been painted with banana oil radiator lacquer to make it brass color.

F. G. SMITH (American Brass Company, Waterbury, Conn.): Hearing this discussion about the copper tubes and their becoming brittle is something entirely new. I have been familiar with copper and its uses a good many years and know how tubes are made and what can happen to them. It seems incredible that reports of this kind should be made, because, for instance, we make our small $\frac{3}{4}$ -inch tube such as you use, from billets about $2\frac{1}{2}$ inches in diameter. These are hot rolled to a tube about $2\frac{3}{8}$ inches in diameter with about $\frac{3}{16}$ -inch wall, and because they are hot rolled they are annealed. From then on that copper is drawn down to the finished size without any annealing at all. This severe cold working does

not make the copper brittle. It is finally annealed as a last operation and you get that sort of tube.

Of course, we know that cold working of any metal hardens it, but copper is one of the most ductile metals there is. It can be bent back and forth a good many times. So whatever bending you would do with copper when installing it could not possibly make it brittle unless the copper was not sound in the beginning. Copper tubes are used on airplanes and they are tested by the government. They have to withstand many thousands, even millions of vibrations with a stress of 10,000 pounds per square inch, which is close to the elastic limit of the copper, before they actually break from the hardening that is referred to. One cannot exactly call it brittleness. The tubes are finally fractured by work hardening due to cold working.

It is reported that copper tubes become brittle, but it does seem impossible that they could become so if they were good in the beginning. Almost anything can happen to copper tube and it will still keep its original cross section. Hit it or drop it and it will not break as reported. There are some brass pipes that contain as much as 40 percent zinc. They will sometimes become brittle under ground because they are corroded by the soil from the outside. I have examined many such pipes. The user often claims that they were brittle copper pipes. We have found that they looked like copper pipes, but originally they were brass. Perhaps something of the kind has occurred in this case. I cannot imagine how pure copper service tube could become brittle from use or from the usual necessary handling incident to installing it.

If copper which has not been deoxidized is annealed in a reducing flame, or in a reducing hot atmosphere, the oxygen will be taken out of the copper and the copper will become brittle. Copper for tubes is deoxidized when it is cast. If the product is found to be brittle, when it is bought, it is not a good copper tube. A good commercial annealed copper tube could not, in my estimation, possibly become brittle by the bending incident to installing it. It would become stiff, but not brittle.

MEMBER: I should like to ask if your experience with electrolysis results from using the copper tubing with the galvanized iron.

MR. SMITH: Mr. Wiggin who spoke just before me explained in a few words the whole answer to your question. If you connect steel

to the copper, or iron to the copper, the immediate iron or steel within an inch or so of the copper is corroded more rapidly than it is elsewhere, but it does not affect the whole line. This galvanic action, which some call electrolysis, will only extend for an inch or so upon the iron or steel.

I think the Society's recommended practice advises that the corporation cock should be extended a quarter of an inch or so inside the main. The reason for that, of course, is that the slight local galvanic action upon the iron will not clog up the opening.

MR. WIGGIN: I suggested to Mr. Hibbs that he bring some of those samples of that brittle tube in here and let us see what has happened. Perhaps he has some of them here with him now.

MR. HIBBS: I did not bring any but I still have the same sample that you have in mind in my office.

MR. SMITH: I will say this. I hinted that no producer can claim absolute perfection of copper tubes. Sometimes a bad coil or length is shipped in spite of the care taken. Such a coil might be bent and straightened, yet if it were given a sharp bend it might not appear so good. That is a fault in manufacturing. It is not an inherent fault in copper.

MEMBER: Is it not a fact that if copper pipe does become hardened from uncoiling and recoiling a manufacturer of any metals of that type will tell you that you can build a fire and anneal that pipe the same as a spinner would?

MR. SMITH: Yes, that can be done.

MEMBER: It is the same as a sheet metal manufacturer. He has to anneal metal several times to get the shapes and forms. You can do the same thing with copper.

MR. SMITH: If the copper gets too stiff to handle easily, take a plumber's torch and warm it. It anneals at 350 degrees Centigrade when not even red hot. Heat it to just a dull red and it will be annealed enough so that it can be bent again.

(*Note to Editor:* Mr. Hibbs has, since the meeting, kindly submitted a sample of the tube in question for examination. We find that the tube was made from very high purity deoxidized copper but that originally it was not annealed so soft as it might have been. It was

not brittle, but on account of having been bent once or twice it was stiff as compared with a new, fully annealed tube. If it were bent sharply back and forth it became kinked and broken. The tube was in no way defective when it was new, nor had it developed any "brittleness" whatever while in service.—F. G. S.)

NEED FOR COOPERATION BETWEEN ARCHITECT, PLUMBER AND WATER DEPARTMENT

JAMES E. GIBSON:¹ The conservation of time and saving of effort required by modern life dictate that the home be fitted to give maximum comfort, comparable with the affluence of the owner. We are living in an age of specialized trades and professions and therefore to build and equip a home to be other than just a place to eat and sleep requires that all of the various trades and professions be consulted. A home should include comfort, convenience, restfulness, light, air, warmth in winter and coolness in summer, where we may entertain our friends and acquaintances or retire in peaceful quietude to woo our individual muse; and last, but not least, it should be beautiful in all of its appointments for "a thing of beauty is a joy forever."

Of the necessary appointments of a home none is more essential than the plumbing fixtures and water supply. That an ample supply of water should be furnished for the various necessities of the household, and that these necessities vary with the affluence and size of the family is almost axiomatic; nevertheless, the most humble home now has hot and cold water in the kitchen and one bathroom fitted with lavatory, tub, and closet. It is the rule rather than the exception that water is being used in the kitchen at the same time that the head of the family is shaving or taking his morning bath; and I regret that it is the exception rather than the rule that the bathroom gets an adequate supply of water under these conditions. Who is to blame? Too often it is the owner himself in his mistaken effort to economize on the first cost of construction. Few of us build or own more than one home in our life-time, so why save a few dollars in first cost when the spending will so increase the comfort and enjoyment of the home in which we live? Many times the blame may be placed on the architect or the designer, and possibly in the case just cited it can be attributed to him, due to his failure to properly place the conditions before his client. Again it may be ignorance or

¹ Manager and Engineer, Water Department, Charleston, S. C.

lack of knowledge of the existing conditions in the locality in which the home is being built. It may be due to the plumber, but usually this artisan is bound by fast specifications and his suggestions are rejected with scant courtesy. If the plumber offers advice before or at the time of bidding, his suggestions are resented by both architect and builder; and if made after he is awarded the contract, ulterior motives are assigned as a basis of the recommendation.

It is a rare case that the water works manager or superintendent is consulted, but in the end he, or his department, comes in for all of the blame for the sins and omissions of the other two, for the owner has paid his bills but is not receiving satisfactory service.

Water has all of the physical properties of matter—viscosity, weight, mass, inertia, etc., and therefore requires work to be performed to change its condition of rest and position. Electricity on the other hand lacks these physical properties and therefore the voltage (pressure) will be the same, within limits, regardless of the fact that the point of demand may be at the top of the house or building and on the highest elevation in the city.

Someone has given the following as the requirements of modern plumbing:

	GALLONS PER MINUTE		
	Fair flow	Good flow	Excellent flow
Kitchen sink bibbs.....	2	4	6
Pantry sink, high goose neck cocks....	2	2	3
Pantry sink, large plain bibbs.....	4	6	8
Vegetable sink bibbs.....	2	4	6
Laundry tray bibbs.....	4	6	6
Slop sink bibbs.....	3	4	6
Basin cocks.....	2	3	4
Bath cock, either hot or cold.....	3	4	6
Shampoo spray.....	$\frac{1}{2}$	1	2
Shower baths, 5-inch rain heads.....	2	3	4
Shower baths, 6 $\frac{1}{2}$ -inch rain heads.....	2	3	5
Shower baths, 8-inch rain heads.....	4	6	8
Needle baths.....	20	30	40
Manicure tables.....	1	1 $\frac{1}{2}$	2
Bath tub.....		10	
Lavatory.....		5	
Water closet, tanktype.....		5	
Water closet, flushometer type.....		30	
Laundry tub.....		10	
Garden Hose.....		10	

I believe anyone will agree with us that few service pipes have the capacity to deliver the quantities of water as required by even the second column in the above table, entitled "Good Flow," when more than one or two fixtures are being used simultaneously. Many of the modern homes today have two and three bathrooms, with bath in servants apartments; and water in garage in addition to the kitchen. The water department's aim and desire are of course to supply the consumer with all of the conveniences, realizing, however; that to do so the peak demand on the system will be raised without necessarily increasing the total supply delivered to any one consumer. It has been necessary therefore to place in his rate schedule a demand or service charge to meet, in a measure, the increased cost of larger filters, pumps, boilers, and distribution mains required by this peak demand.

The architect and plumber are as anxious, of course, to supply the wants of their clients, but they are not in the same position as the water works man in that the water works man must live with the job furnished by the other two throughout its life, and as intimated before, he is the one that comes in for the criticism. All three are limited by certain conditions. Some of these conditions are placed upon them by the owner, as follows:

1. Cost of fixtures and supply pipes.
2. Operating cost, which includes the demand charge.
3. With the increase of plumbing fixtures for the convenience of the owner, the owner is faced with the possibility of larger bills due to leakage or failure on his part to maintain these fixtures.

The water department, however, is limited by natural forces:

1. Location of property as to elevation, and location from the pumping station or distributing reservoirs.
2. Nature of the territory as to the demand at peak consumption.
3. The height of the building and the highest fixtures in the building.
4. Location of the building as regards the street and supply main.
5. The pressure that the water department can maintain on the system at that point during peak demand without placing undue or exorbitant pressures on other parts of the system and at off-peak demand.

To compose all of these conditions, it is increasingly necessary for the owner, architect, and water works official to get their heads together

so that when the home is finally completed, it will at least approach that picture (in the mind of the owner) of a comfortable and enjoyable place in which to live.

It is no doubt the experience of all of us to find that the architect has in many cases designed the plumbing with the flushometer type of toilet regardless of the pressure available and has gone even further and ignored the fact that larger service pipe is necessary so that what pressure is available is not used up in friction loss to deliver the quantity of water required. In many cases several bathrooms have been added, having modern fixtures—shower and needle baths, etc.—again overlooking the fact that several of these fixtures may be used simultaneously and the demand will be larger than the pipe can supply. Then we have the case of the small home where the architect is eliminated in an effort to save cost and the local builder and plumber act in his place. Here, the plumber in an effort to keep the cost down to meet the demand of the builder, installs small service pipes and small leads from these to the fixtures without considering the possibility of the peak demand on the lines. Then we have both the architect, builder and plumber overlooking the fact that the pipes corrode, tuberculate, and incrustate, so that while the delivery in a new building may be ample, after a few years' use it becomes inadequate due to these natural causes.

The water works man, being acquainted with the natural conditions as to location, the hydraulic conditions, the nature of the water and its natural qualities, is fully able to supply all of this information and would gladly do so if called upon in time.

In this connection I would like to call attention to a fact that I have often observed; namely, the plumber, usually trained particularly in the matter of drainage plumbing of buildings is scrupulously careful to avoid all unnecessary bends in the drainage lines, but when he comes to install the supply plumbing, right angle elbows and return bends are used without rhyme or reason as if the friction losses in these pipes and fittings are immaterial. While I do not endorse it, someone has said that seven right angles are equal to a blank.

I have not attempted to touch all of the phases of this problem but to point out the growing necessity for cooperation between all parties—owner, architect, plumber, and the water department.

T. A. LEISEN (Omaha, Nebr.): On this particular question, I desire to go back quite a number of years to an experience of my own,

as an owner and not as a water-works representative. I want to enter an apology for putting the blame of inadequate sized service on the owner, and lay the blame on the water department.

My first venture at house keeping was in a rented house, where I found, as Mr. Gibson suggested, that when they happened to be using water in the kitchen I could not get sufficient supply in the bath room. So when I planned and built my first home, I arranged for a 1-inch water service line throughout the full length of the basement with connections of adequate size from this 1-inch service to all connections on first, second and third floors. When I made application to the Water Department for a 1-inch tap and 1-inch service from the main to the premises, I was turned down flatly and told that $\frac{1}{2}$ -inch corporation cock and $\frac{5}{8}$ -inch lead service to the building would give me all the water I needed. It took nearly a week of persuasion and effort to finally induce the Water Department officials to grant me a $\frac{3}{4}$ -inch corporation cock and a 1-inch service from main to building, and with this arrangement we were able always to get an adequate supply of water in all sections of the house.

Since that time, in my capacity as representative for various water departments I have always been very sympathetic towards the requests of builders or owners for larger sized service, and have in fact encouraged most builders to put in larger services if their original sized design seemed inadequate.

I believe that architects, builders and plumbers in general would not raise serious objection to installing service pipes of an adequate size, as the difference in cost is not of sufficient moment to prevent them from providing for a water supply that will always be satisfactory as to quantity. The water departments should be willing and glad to give every consumer a service large enough to enable him to use all the water he may require, and thereby profit by increased revenue, assuming, of course, that the general water supply of a city is ample to meet requirements of all inhabitants thereof.

L. N. THOMPSON (St. Paul, Minn.): It seems to me that a water department should take the lead in deciding the question of service pipes. In St. Paul several years ago we worked under a rule that limited the size of services to the average home, which rule has since brought us more or less difficulty. During a year when consumption

is very high, particularly during a summer such as we had last year, the home owner has considerable trouble in securing sufficient water through a small service to supply all fixtures, or several fixtures at the same time. In place of checking the size of a service we have now established a minimum size of $\frac{3}{4}$ -inch. We have even gone further than this and require in our plumbing rules that the service, whatever size it be entering the house, be continued full size entirely across the basement or the last fixture connection. This is, I believe, very important, because if the pipe is reduced as the house fixtures are taken off, you will usually find, as Mr. Gibson states, somebody in the house will be trying to draw water in the kitchen or upstairs at the same time, and, in the summer, also using the lawn hose at the same time, with the result that but a part of the fixtures are able to obtain water. So it is important that the full size of service be available to all fixtures.

We have in St. Paul a service charge, based upon the size of the meter. We find that the average home owner, particularly during a period of depression such as now exists, tries to economize even on his water bill. This creates a demand for a reduction in the service charge, by reducing the size of the meter. This again requires considerable tact, as a reduction in meter sizes to economize on the bill also reduces the house pressure due to increased loss in the smaller meter. Since the home owner is not familiar with the relationship between pressures and meters and the size of the service pipe and his plumbing, I believe it is the duty of a water department to regulate such sizes as a matter of protection to both the consumer and the department.

THOMAS H. WIGGIN (New York, N. Y.): I do not know if what I am going to say is particularly pertinent, but it seems to be taken for granted that most of the trouble will be in the outside part of services. In my recent experience I am convinced that much of the trouble may be elsewhere. I am wondering whether Mr. Gibson, or the others, can throw some light on this.

I found that even after putting in a new copper service, which gave the cold water plenty of pressure, the hot water pressure was deficient. I found that in the boiler there was a very small cold water inlet pipe no bigger than my little finger, and the end had some small perforations. As nearly as I can figure out all of the supply in the common hot water system goes through such a little pipe, spreads

out in the boiler and then goes back in the hot water supply pipes. I think there must be more loss of pressure in that little pipe and its perforations than in the remainder of the service. It looks to me as if there is need for what may be called a household engineer. The engineering stops too abruptly outside the house and is not carried through the whole distance.

MR. GIBSON: Answering Mr. Wiggin I wish to say that I agree with you that there should be a household engineer and theoretically, if not practically, he should be the plumber. The plumber is a patient fellow. He will go on the job and send his helper back for his tools and wait all day for that boy to come back, and the owner pays the bill.

E. O. SWEET (Birmingham, Ala.): I would like to come to the defense of the plumbers, if you will allow me.

If you are going to build a home you meet one of two conditions, either the service pipe has been laid to the curb, or it has not. If it is in to the curb, it is because there is an ordinance regulating the size and material to be used for such service installations. If it is not in up to the curb the city will be found to have an ordinance regulating the type of material only, seldom the size of pipe. In either case the first man to want water is the brick mason and the plumber picks up the service at the curb or main and puts up a riser with a $\frac{1}{2}$ -inch spigot for the brick layers.

I dare you to pick up an architect's specifications, unless it be one for a home costing from fifty thousand dollars and up, and get from the specifications the size of pipe that is to supply the dwelling. You cannot find the size therein. He has the type of pipe and fixtures that are to be used, but not the size of the service pipe.

The plumber is not such a bad fellow. Unlike most of us, he has not had an education beyond the high school. He knows little or nothing of hydraulics. He has been a journey man, maybe a boy starting in, and he tries to do an honest job, outside of running back to the shop for material, but he cannot be accused of that at the time the service pipe trouble started, because he was then working under a contract. He had to bid to get the job.

If it were a replacement job I would agree with your accusations of him, but not at the time the original installation was made, and that is the time the trouble started. Later, when the house was framed,

he picked up the pipe at the mason's spigot and brought into the house a $\frac{1}{2}$ - or $\frac{3}{4}$ -inch, and the size was too small.

Let me tell you of my experience in Birmingham which plant is controlled by the same interest as that of Mr. Porzelius. Our rule is that a complaint embracing lack of supply or pressure must be serviced within 24 hours. These types of complaint are many during the summer months and I find that in at least ten percent of the cases the trouble is with the water company. We have made it a fixed rule for the engineer never to go out and make his tests and recommendations as to sizes of pipe to be installed in order to receive good service, until the meter has been taken out and we know that it is not stuck or that the service pipe has not had the flow obstructed during the putting in of sewers or laying of pavement. After the tests are completed we recommend to the owner the size of pipe he should use and the points to which the new installation should be carried.

We are constantly recommending that the owner carry the new pipe clear across the basement to a point under the kitchen fixtures. The trouble was that when the original line came inside the front wall it was immediately turned back for a front yard sill cock and this opening when in use took up the entire capacity of the service pipe. Then there was not enough incoming pipe capacity to carry water on to the baths and kitchen fixtures. The plumber was not to blame for that, was he?

We make it a point to work with the architects and real estate companies, inducing them to seek advice from our office with reference to the proper size of service line.

On our low service system, we have a variation of three hundred feet in elevation; architects are unaware of this fact. He knows he is to build on a hill or in a hollow and we try to advise with them as to pressures at various locations on the system so that complaints will not be made later after the dwelling is occupied.

On the high service system main pressures vary from 30 to 200 pounds. As a water works man, I would say this subject comes back on us fellows and not on the plumber, more on the architect and more so on the water works men who are not dilligently pursuing methods to remedy such conditions.

So I say to you that we have no business to blame the plumber because 90 percent of your trouble started with the original installation, where the plumber had nothing to do with the size of pipe installed.

MR. GIBSON: I have no grouch on the plumber. I have the grouch on some of his practices. I am glad that Mr. Sweet came to the plumber's defense. I will admit that, if I had to do some of the work the plumbers have to do that I would be glad to be patient, too. But nevertheless the question all comes down to the subject of the paper "Cooperation Between the Architects, Plumbers and Water Works Man." How can we get that cooperation?

You know cooperation is a nice word in the dictionary, but it is a hell of a poor word to work by because it usually means to cooperate with a man you must do as he says and not as you would like to do. In other words there is no diplomacy in this thing. But there should be. We have in the past at Charleston worked very nicely with both the plumber and the architect. We do have some trouble sometimes with the owner, because our minimum charge is based upon the size of the service pipe. We set all of our meters at the curb because very few homes have any cellars or basements. The owner very seldom comes in to arrange for a service but sends his plumber. The plumber draws up his specifications and the first question is, what is the water service line going to cost.

MR. SWEET: That is all the owner cares about, what it is going to cost him.

MR. GIBSON: That is right. We base our minimum charge on the size of service pipe, so we tell the plumber a $\frac{3}{4}$ -inch service will cost so much, a 1-inch service, so much, etc. And then the plumber, as Mr. Sweet says, is under a contract and so he says: "Oh, I'll take the $\frac{3}{4}$ -inch service." Then you may try and argue with him, but he won't listen to you. It is too late. When we can get the architect to consult with us, or let us know, in advance that he is designing a house in a certain locality, or the owner is going to build, why then we can usually get cooperation on the right sized service. Usually however it is as Mr. Porzelius has said; he does not come to us until the house is built and, he has forgotten until then, that he wants water.

It may then be too late, the cost has overrun the estimate so the owner will take the smaller size service. If we could get cooperation, it would be all right. Why the owner should hesitate so long, I do not know. It is like buying a suit of clothes. It is all right to buy a cheap suit of clothes because it will wear out in a few months

and you will forget about it, but if you are buying a mattress or a set of springs to sleep on you are probably going to sleep on them for ten or fifteen years and it pays to get a good mattress and a good pair of springs. Therefore, when it comes to plumbing it is a good thing to put in good sized service pipes even though it does cost a little bit more for the water, because you use the water and you get the pleasure and comfort and you do not have to holler down to your wife to shut off the water in the kitchen until you can finish shaving or get your bath.

STERILIZING MAINS

WILLIAM W. BRUSH:¹ This subject is divided into two quite separate divisions of new mains and repair work. While the action to be taken may be similar, the separate treatment of these divisions is considered advisable. Sterilizing new mains will be discussed under the following two captions (1) care and treatment of pipes in the laying process and (2) sterilization after pipes are laid.

CARE AND TREATMENT OF PIPES IN THE LAYING PROCESS

It is usual practice to deliver pipe along the line of the work days in advance of laying. In the interval between delivery and laying the pipes are exposed to contamination by the waste products of animals and human beings and by the dirt and litter of the street. In the sparsely built sections this contamination is less in amount and importance than in the closely inhabited areas, but it is present in all. The writer believes the pipes cannot be adequately protected in this period, but advocates that in congested areas they should be delivered just before being laid and thoroughly cleaned by brushing just before they are placed in the trench. Unless the pipes are free from an accumulation of earth and other matter, the subsequent sterilization cannot be effectively carried out. Our experience with large steel mains, which cannot be cleaned of dirt when in place by high velocity flushing conclusively shows that the interior must be cleaned by hand washing if the pipe line is to be sterilized by one application of chlorine.

After dirt has been brushed out and the pipe laid in the trench care must be exercised to prevent mud and dirt from entering the pipe

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and at night the open end should be closed by a plug to prevent contamination by animals and children.

STERILIZATION AFTER PIPES ARE LAID

It has been the practice of the New York Water Department for many years to require either a tablespoon of chloride of lime to be thrown in each pipe or to require sufficient chloride of lime to be placed at each gate so that the water flowing into the pipe would have a chlorine content of at least three parts by weight per million parts of water. The chlorine water is allowed to stand for several hours in the pipe and is then thoroughly blown out and for 12-inch and larger pipes a sample of the water passed through the pipe is taken and examined by the laboratory as to presence of *B. coli* and other bacteria.

If the laboratory report is unfavorable, the main is again chlorinated using a portable liquid chlorinator or else the main is again thoroughly blown out and the sample of water again tested.

The bureau instructions as to sterilization by using a field gas chlorinator are as follows:

MEMORANDUM ON THE STERILIZATION OF WATER MAINS BY THE USE OF CHLORINE GAS

To aid the department employees who may be engaged in the work of sterilizing water mains by the use of chlorine gas, the following data has been prepared:

Description of equipment

The chlorine control device consists of a chlorine injector and back pressure valve mounted on a panel.

The back pressure valve is merely a diaphragm and spring, which reacting to the water pressure in the main operates a needle valve to open and close the orifice, preventing a back flow of water into the apparatus, when the water down stream equals or exceeds the pressure up stream.

The injector consists of a small Venturi tube connected in the water stream, which is tapped at the throat connecting this point to the chlorine supply. The water flowing through the Venturi tube creates a vacuum at the throat, which introduces chlorine into the water, and this chlorine solution is delivered into the main to be sterilized.

Working conditions required for proper operation

The chlorine apparatus is connected across a valve located between the existing distribution system and the new main to be sterilized, thus placing the distribution pressure on the up stream side of the injector, with a lower pressure on the main to be sterilized. The amount of chlorine that can be absorbed into the water is proportional to the drop in pressure across the injector, and it has been found that excellent results are obtained where the pressure down stream does not exceed $\frac{1}{6}$ of the up stream pressure, also that satisfactory conditions will not be obtained where the down stream pressure is higher than $\frac{1}{4}$ of the up stream pressure.

Where this minimum pressure cannot be obtained due to the pressure in the distribution system, an auxiliary pump may be required to increase the pressure on the inlet side of the injector. For this purpose we have obtained a gas driven centrifugal pump with a capacity of 10 g.p.m. against a total head of 100 feet, which is found to work satisfactorily, and to meet all operating conditions.

The housing of the equipment during operation, and the handling of the equipment controls require careful attention.

Under ordinary summer temperatures chlorine can be extracted from the cylinder at the rate of about 20 to 30 pounds per 24 hours. Higher temperatures increase the draft rate, while lower temperatures reduce the rate.

It is, therefore, essential that the apparatus including the chlorine cylinder be enclosed and protected from the sun in the summer, and that a kerosene oil heater or three or four lanterns be used to raise the temperature in winter time, thus by this means a uniform delivery of gas can be obtained and the machine once set will require little or no further attention.

The chlorine cylinder is provided with a main tank control valve, which should be supplemented by an auxiliary tank control valve. This tank valve is connected to the cylinder by means of a yoke, a soft lead washer being used in the joint.

The joint should be made up firmly, with the small wrench provided with the equipment for this purpose. If the joint is made up too hard or too tight, the lead washer may spread under the pressure and close orifice.

By making up joints firmly and subjecting them to the gas pressure, any existing gas leaks can be readily located by the use of

ordinary house ammonia, which turns to a white vapor when in contact with chlorine.

The joints should be made up just tight enough to prevent leakage, and no wrench larger than those provided with the equipment should be used.

The employees handling the equipment should also be warned against rough handling of the chlorine container, as this tank is equipped with a fusible soft plug, which may become dislodged if the tank is dropped or roughly handled.

Operation of the equipment

The equipment should be installed on the highest point on a new main where a connection between the existing distribution system and the new main is available, so as to provide the largest variation between the gradient in the system and the low point on the new main where the blow off is located.

After the equipment has been installed, and is ready for operation, a flow of water is introduced through the injector, and then by means of pressure gauges established on the old system and new main the drop across the injector should be adjusted to a six to one ratio by opening the valve between the old and the new mains until this condition is obtained.

When the water is passing through the machine under these conditions, the control valves on tank and machine may be opened, and the flow of chlorine controlled so that the maximum amount of chlorine is passed through the machine without blowing chlorine through the cup on top of the vacuum breaker.

The machine is operated under these conditions until the chlorine solution has reached the nearest hydrant on the new main, where samples of the chlorine solution can be taken and examined by means of the Orthotolidin Standards to determine the amount of residual chlorine in the water.

This chlorine content, for satisfactory results, should be from 1 p.p.m. to 5 p.p.m. and should not exceed 5 p.p.m., as a chemical reaction is set up between the coating on the pipe and the chlorine, leaving a taste in the water which is difficult to eliminate afterwards.

The chlorine machine is continued in operation until the chlorine solution has traveled in the new main for a distance of about 1000 feet in long mains or for a period of about four (4) hours in shorter mains, when the machine may be shut-off, and the chlorine solution

allowed to move slowly through the main until it is wasted through the blow off.

By testing with the Orthotolidin Standards on the hydrants along the line, the progress of the chlorine solution in its passage through the main can be noted, and when the samples no longer show a residual chlorine, bacteria samples may be taken to be submitted to the Laboratory for test.

In closing down the machine, the gas should be shut off at both the main tank valve and auxiliary tank valve before any other operation is undertaken, and the water allowed to run through the injector for a period of five (5) minutes to entirely extract any chlorine which may remain in the machine. If the water is shut off before the gas is shut off, the gas pressure will build up and blow into the atmosphere through the cup at the vacuum breaker.

This same condition will result if any valve is closed on the new main, which would have the result of stopping the flow of water through the injector tube.

Conditions which have materially facilitated obtaining satisfactory results

It has been noted that chlorine solution will not penetrate below the surface of any sediment which may remain in the main, and that difficulty was encountered where dirt or foreign matter could lodge in the joints between the pipes. To eliminate this it is the practice to have the joints in large mains painted with a saturated chlorine solution so as to introduce the chlorine as far as possible into the crevices at the joints.

It has also been noted that difficulties have resulted from carrying sediment from existing mains into the new main to be sterilized, as this sediment contains coli, which grows rapidly in the water in the new main. This has been eliminated by blowing hydrants on the distribution main from which water is to be fed for sterilizing purposes. If the existing main is blown at a rate in excess of the rate at which water will be introduced into the new main, the existing main will be free from sediment, and only clear water introduced into the new main.

In sterilizing steel mains a minimum period of contact between the chlorine solution and the walls of the new main of four hours has been found to produce satisfactory results.

STERILIZATION OF REPAIR WORK

The repair gangs are instructed to be especially careful to prevent sewage contaminated water or earth to enter the pipes and to place chloride of lime in the pipe where the repair has been made if there is any chance of contamination and to thoroughly blow out the main. Very large trunk mains after repairs have been made are frequently tested as to quality of water before the main is restored to service. It is not usual practice to test the smaller trunk mains after repairs are completed.

CONCLUSION

One would not willingly or knowingly drink from a contaminated glass or other container. The public looks to us to give them water delivered through pipes free from contamination. We should strive to do so and should not neglect any reasonable precaution to see that such a standard is attained and maintained.

ROBERT SPURR WESTON (Boston, Mass.): There are two methods, as you all know of disinfecting water mains: one is to place a disinfectant, like chlorinated lime, in the filled pipe; let it stand for twelve to twenty-four hours, and then draw off the water. This method I am not going to discuss. I am going to confine my remarks to the continuous method of disinfection.

In one case, that of the disinfection in the Wanaque Aqueduct in Northern New Jersey, this method has been described more in detail in another place by Mr. Attmore E. Griffin, associated with our firm. For reference purposes some of the details might be printed with advantage in connection with Mr. Brush's paper.

The Wanaque aqueduct conveys the waters of the Wanaque reservoir to certain cities in Northern New Jersey, Newark, Patterson, Passaic, Clifton, Montclair and others among them. There are nine of them in all. This reservoir drains 94.4 square miles and the water from it is of high character. It is soft and practically free from *Bacteria coli*. However, the aqueduct had to be sterilized before even this good water could be placed in it for service.

The aqueduct consists of an 84-inch combined steel pipe and concrete lined tunnel about 1900 feet long, which discharges into two 74-inch steel aqueducts. The total length of the aqueduct is twenty and a half miles. For a considerable distance there are two 74-inch

pipes; but below the Watchung Mountains, where the water passes through a tunnel a single line continues on to the Belleville Reservoir, which supplies the City of Newark.

The first precaution taken in disinfecting of this pipe was to have it clean. It was delivered right from the cars and laid quickly. The joints were painted with asphalt before disinfection was begun, that is, before it was filled, and naturally the pipe was swept out and thoroughly cleaned.

The specifications called for two and a half pounds of chloride of lime for every hundred lineal feet of this 74-inch pipe. This was equivalent to about 2.3 parts of chlorine per million.

The use of so much chloride of lime in an aqueduct 20.5 miles long, part of it double, did not appeal to those in charge of the work and it was decided to use the continuous process and substitute liquid chlorine for chloride of lime. Accordingly, two Wallace and Tiernan chlorinators, which Mr. Brush has described and which many have seen, each capable of discharging four parts of chlorine per million in ten million gallons of water daily, were installed in the upper gate house near the reservoir dam.

The general plan of disinfection was to add to the flowing water, about 6 parts of chlorine per million for the first few hours, and follow that with a dose of 4 parts per million, continuing the application at this rate until a minimum of 2.0 parts per million of available chlorine were maintained near the end of the line, or at the Belleville Reservoir 20.5 miles away. Water was flowing through the aqueduct at the rate of ten million gallons a day while disinfection was going on.

This general plan was being carried out. Expectations were exceeded, however, and 3 parts of residual chlorine per million were obtained at the Belleville end of the aqueduct. In other words, a large part of the chlorine which was put into the upper end came out at the lower end and did its work on the way. This was because the water was of high grade and did not consume much chlorine on the way. With water of high organic content, or turbid water, the effect would have been different.

For the sake of brevity, details are omitted, but it took five days, four hours and forty-five minutes for the water to make the journey of 20.5 miles through this aqueduct. This was very close to the computed time, or equivalent to a rate of about 870 lineal feet per hour.

It was planned to drain the water off immediately and fill the pipe

with clean, unchlorinated water from the reservoir, but very soon, for structural reasons, the flow in the aqueduct had to be stopped. This gave an opportunity to check the amount of residual chlorine in the whole 20.5 miles between the dam and the Belleville Reservoir.

It was found that the residual chlorine in the section between the end of the line and the tunnel, which was about half way to the dam, approximated 1.0 part per million; in each of the twin lines running to the dam it approximated 1.5 parts per million.

After a lapse of twenty-four hours the chlorinated water was drawn from the aqueduct and replaced by clean potable water, which was given a small dose of chlorine before being placed in the aqueduct. Samples were collected frequently. Forty samples in all were collected and no colon bacilli were found in any of them; the highest number of bacteria found in any of the samples was five per cc. It was therefore concluded that disinfection was complete.

The quality of the water was good during the whole operation and the bacterial examination showed the efficiency of the process. The work was done under the joint charge of Mr. Joseph A. Ward, a hydraulic engineer of the North Jersey Water Supply Commission, and Mr. Griffin, to whom I have already referred.

H. W. GRISWOLD (Hartford, Connecticut): The standard method in use at the present time by The Water Bureau of The Metropolitan District at Hartford, Connecticut, for sterilizing new water mains, consists in inserting into the pipe line, about every six or eight lengths, or roughly every 100 feet, a half-pound of hypo-chlorite. In a 6-inch pipe, this dosage figures about 18 parts per million free chlorine; and in a 16-inch pipe, 3 parts per million, either of which, of course, is amply sufficient for sterilization.

Some consideration has been given to the saving which could be made by decreasing the dosage in the small lines, but the advantage of having one standard procedure for all distribution mains seems to outweigh any possible resulting economy, so that the standard dosage has been continued.

During the laying of water mains, great care is taken to see that the pipe is as clean as possible when it goes into the ditch and that the ends are kept closed during the pipe laying operations, especially if there is an appreciable amount of water in the trench.

As soon as the line is completed and connected to the supply, it is filled and allowed to stand for at least one half-hour. The chlorine

solution is then flushed out, care being taken to flush from all directions, and to so conduct the flushing that there are no pockets left in the line in which the chlorine solution might remain. This flushing is continued until ortho-tolidin tests made on samples from the outlet show no appreciable amount of chlorine; in other words, show a very light green, or are colorless.

Mains are usually flushed into sewers, through surface blow-offs into gutters, or occasionally through hydrants. In special instances, where adequate flushing facilities are not available, a 1½-inch corporation cock is installed in the main and flushing is carried on from this through an ordinary fire hose.

The Water Bureau has a portable outfit for chlorinating new mains with liquid chlorine, manufactured by Wallace & Tiernan, which is used when a long period must elapse during or between the construction of the pipe line and its filling with water.

The principal difficulties encountered in using a portable chlorinator are the trouble experienced with freezing during the winter, and the fact that the back pressure on the chlorinator cannot exceed 25 pounds for proper operation.

During the last winter, the Bureau supervised the installation of a water supply for a neighboring community to which the feed line was under construction, and, in this case, the HTH powder was omitted on advice from a consulting chemist, as there seemed to be some possibility of chemical action between this powder and the cement lining, or coating, if the two were left in contact over a long period in moist air.

These lines were sterilized with a portable chlorinator, after the completion of the distribution system, with the feed adjusted to give six parts per million residual chlorine.

N. A. THOMAS (Milwaukee, Wis.): To conform with the advanced standards of sanitation generally recognized, the Milwaukee Water Works has, in recent years, been giving more attention to the quality of the water in the distribution system than ever before. It has been the practice for several years to use some method of disinfecting water mains immediately after laying and before placing them in service. Along with this sanitary measure regular bacteriological analyses of water samples taken at representative points throughout the distribution system are made for the purpose of comparison with the quality of the water found on corresponding samples at the pumping stations,

after regular chlorination. On account of the marked similarity in bacterial quality between the station samples and those taken in the distribution system during the last four years, an annual or semi-annual sterilization of old mains has not been considered necessary. On the other hand, pollution in new mains is almost inevitable, and, if allowed to enter the distribution system, presents a health hazard that is extremely difficult to overcome. As a precautionary measure, a water main sterilization policy has been adopted at Milwaukee.

Prior to the year 1930, calcium hypochlorite was used as the sterilizing agent for newly constructed water mains. This chemical was replaced by liquid chlorine which was also used in the chlorination of the city reservoir and the new elevated storage tank completed that year. It has been found that sterilization by chlorine gas is far superior to treatment with calcium hypochlorite. Any mud that remains in the pipe after flushing and before treatment is not completely sterilized by the chlorine from the hypochlorite, and must be removed by successive flushings to assure effective sterilization of the main.

The most recent sterilization of a new main was effected by means of a portable chlorinator of the direct feed type used solely for disinfection in the distribution system. This main, located between E. Capitol Drive and E. Hampton Road, is 16 inches in diameter and over one mile in length, having a volume of approximately 60,000 gallons. It is fed from the 54-inch main at E. Capitol Drive and Richards Street.

The chlorinator used in the sterilization controls the removal of the chlorine gas from the containers, measures accurately the rate at which the chlorine is being applied, and insures continuous uniform treatment of the water to which it is applied. With this type of apparatus the chlorine passes from the container in the gaseous state through the main and auxiliary tank valves and then through a flexible tank connection to the apparatus proper, which is housed in a strong oak cabinet making it easily portable. The gas then passes through the chlorine control valve which is the mechanism for changing the rates of flow of chlorine as desired. This flow is indicated by a meter and may be increased or decreased by opening or closing this valve. After passing through the control valve and orifice meter, the gas passes through a connecting tube of suitable length into a check valve, which maintains the desired back-pressure on the apparatus and prevents water from getting back into the instrument.

In the dry state, chlorine gas is not very corrosive, but in the presence of moisture it has an extremely corrosive action causing rapid deterioration when coming in contact with the chlorine control apparatus. The check valve is set to open at a predetermined pressure, and until this pressure is built up no gas will pass through the valve. With this equipment the chlorine check valve serves the purpose of holding the chlorine gas at a constant density as it passes through the meter, which insures the true indication of rate of flow of chlorine gas at all times. From the chlorine check valve the gas passes through a diffusing apparatus which consists of an assembly of the diffuser stem and diffuser, corporation cock, receiving chamber and stuffing box for the purpose of inserting and withdrawing the diffuser while the main is under pressure. This diffusing apparatus is connected to the main by means of the corporation cock. The function of the diffuser is to finely subdivide the gas into small bubbles which are readily absorbed by the water being treated.

Before the actual sterilization of this main was commenced, it was flushed four times to remove any solid matter present, and after the last flushing, samples of the water were taken for bacteriological analysis to ascertain the extent of the contamination. The results of the analysis showed that the main was heavily polluted with organisms of fecal and non-fecal strains of the Coli-Aerogenes group. The average number of bacteria per cubic centimeter growing on agar medium incubated at 20°C. was 12,000. Plates incubated at 37°C showed an average count of 1,850 per cubic centimeter. In the test for the presence of members of the Coli-Aerogenes group of organisms, positive results were obtained in the lowest portions taken (.01 cc.). These findings indicate that the amount of pollution entering new mains under construction makes it extremely dangerous from a public health standpoint to place them into use for the distribution of water unless they are previously sterilized.

The chlorinator and accessories were set up at the desired point of application and connected to the side of the main by means of the corporation cock. The application point selected was close to a gate valve connecting the main with a source of water supply. After opening this valve the chlorination was begun at a rate that approximately coincided with the rate of filling. All hydrants along the line were opened to the atmosphere to expel the air. Provision was made for making residual chlorine determinations on the water being treated by means of an artho-tolidin testing outfit. These

tests were made from time to time at different hydrants to check the chlorination process. Applying the chlorine at the same rate of filling the main assured uniform sterilization, and the time required was six hours. A residual chlorine test taken at the end of the line after the main was filled and chlorination stopped was found to be 4 parts per million. The amount of chlorine gas applied to the water used in the sterilization was ten pounds, or 20 parts per million, showing that the quantity required for chemical absorption, oxidation of organic matter and actual disinfection amounted to 16 parts per million, or 80 percent of the prescribed dosage. After completing the chlorination of the main, the chlorine solution was allowed to remain in the line overnight when it was drained out and the pipe again flushed with fresh water to insure complete removal of the heavily chlorinated solution. The line was again filled with regular city water and samples were taken for bacteriological analysis to check the efficiency of the sterilization. The results of this analysis showed that the chlorination process had completely sterilized the main and that all the organisms pathogenic to man were destroyed. The findings showed a bacterial count of 31 per cubic centimeter on agar incubated at 20°C. for 48 hours, and 4 per cubic centimeter on agar incubated at 37°C. for 24 hours; which compares favorably with the regular chlorinated city water. The test for members of the Coli-Aerogenes group of organisms was *negative* on this sample.

Similar results were found in other main sterilization projects in the past, and it is readily seen that the inauguration of a water main sterilization policy is necessary to prevent organisms of pollutional origin from getting into the distribution system. The use of liquid chlorine applied either as a gas or in the form of a solution assures complete sterilization, and in that respect is more reliable than the calcium hypochlorite treatment. It is also more convenient and easily controlled through the chlorine control apparatus, and the problem of the removal of the lime-ash deposits from the hypochlorite is eliminated.

SHUT-OFFS FOR NON-PAYMENT OF BILLS

W. Z. SMITH (Atlanta, Ga.): The question of shutting off water supply for non-payment of water bills during the present depression, presents to all superintendents a very difficult problem. There are many people, who ordinarily pay their water bills, but on account of non-employment are not now able to pay their bills regularly or

promptly. With such people Water Departments necessarily have to be patient. To some an extension of time is necessary, often resulting in an accumulation of several months of unpaid bills. These people are honest and want to pay, but simply have not the money with which to pay. As soon as they get employment they are able to pay their regular monthly bills, but find themselves burdened with an accumulation of several past due bills. In such cases, we believe that the best policy is to allow them to make monthly reduction, by paying part of the accumulated bills each month, with their regular current monthly charge. Some people simply are not able to pay now, nor will they ever be able to pay. They are subjects of charity, and as such have to be dealt with. To deprive them of water would be worse than depriving them of food. They can get food, and can be supplied with cast off clothing by friends and neighbors, but they cannot get water, unless it is carried from their neighbors faucets. Therefore, human sympathy for human need demands a charitable attitude toward these. It is only just that their bills be cancelled. Of course, we have to guard against imposition, and in order to do so we must investigate the circumstances of the homes of these, and where we find circumstances such as will warrant, cancel the bills.

We do not mean that water should be continued where people are able to pay, but will not pay. Such people should be dealt with as is done in ordinary cases, serve them with a notice, and then shut off the water supply.

We have not sought to deal with the question in a sentimental way, but are trying to deal with it in the light of the unusual conditions brought about by the depression in business, as has existed for the past two or three years. The result has been untold suffering, privation and want, and as men we have got to view the suffering of these people in a sympathetic way.

PATRICK GEAR (Holyoke, Mass.): We find that it is always the same people that are slow in paying their water bills, but we do not shut off their supply for not paying their bills promptly. We keep after them all the time. Some can pay but are always slow. We had more uncollected bills on our books last year than we have had for a long time, but these are hard times and money is scarce. If the landlord is unable to collect his rents, it is hard for him to meet his obligations, we do not worry because we can collect on the property.

We keep all our receipts and pay all our bills, so we have to practise economy today like everybody else.

THE EMERGENCY PROTECTION OF WATER WORKS IN FLOODED AREAS

F. E. HALL:¹ The water works at Greenville in the heart of the Mississippi Delta was seriously affected by the floods of 1927.

On the morning of April 21, at seven thirty, a break occurred in the main levee on the east bank of the Mississippi River at Mounds Landing, sixteen miles north of Greenville. There naturally followed a great deal of speculation and suggestions relative to the proper course of procedure for adequately protecting the City from the devastating forces of the flood. The majority of our people, including those in authority, were of the opinion that strengthening of the small protection levee along the northern boundary of the City would afford the most economical and efficient protection obtainable. Therefore, every available man was concentrated on this front line with sandbags for their weapons of war to whip the rapidly rising waters of the flood; they fought a brave battle, but were defeated and had to abandon the fight before midnight with water pouring over the levee for its entire length and finally washing this inadequate barrier away within a few hours.

So great was the confidence placed in this means of protection, that a second line of defense for the protection of the water works was deemed entirely unnecessary; consequently the entire plant with all the equipment, pumps, boilers, and wells, was inundated to a depth of six feet. Needless to say, service was interrupted, and any possibility of resuming operation in the face of the terrific currents of those turbid waters seemed very remote and impractical.

During those first days of uncertainty filled with panic and an ever increasing seriousness of the situation, it was indeed difficult for anyone to formulate any constructive plans for resuming operation. People were wild, some justly so, because of the loss they had suffered in their families and businesses. There is little wonder therefore that this hysteria had affected everyone; many were the impractical solutions formulated for coping with the problems confronting us. Some one suggested the construction of a sandbag levee around the entire water works; this would have soon proved impractical in the face of the terrific currents present, and exceedingly expensive had the same

¹Superintendent, Water Works, Greenville, Miss.

been undertaken. However, this wild idea was abandoned following the discovery of two small private wells situated in the central portion of the City on much higher ground, which therefore had not been flooded to sufficient depth to prohibit operation.

EMERGENCY SUPPLIES

These wells were immediately drafted into service, furnishing water to the City through the medium of fire hose attached to an adjacent fire hydrant. This source of supply soon proved inadequate in developing the necessary quantity of water needed at this time, the unusually large consumption being a result of the hastiness with which residences and other buildings had been abandoned. The people in their haste to leave had not overlooked the need of water, but had made an effort to collect small amounts prior to the interruption of service, and had left these fixtures open after water had ceased to flow; hence gallons of water were wasted through these open fixtures and the few fire hydrants broken by the larger boats plying our streets. This unnecessary wastage gave rise to another problem which is worthy of later discussion.

To supply a sufficient quantity of water we found that it was necessary to supplement the limited supply of the previously mentioned private wells. In our search for an additional source, an auxiliary well in our own system was found to be possible for this purpose. The well was located, fortunately on what proved at the time to be the highest available ground and therefore easily protected from the few feet of water surrounding it, by the construction of a sand bag levee, which was made possible by barging earth to the site from the main levee. This work was soon accomplished and a small gasoline engine driven slush pump utilized to lower the level of the water in the enclosure sufficiently to dry the electric motor which operated a Layne-Bowler deep well turbine pump. This pump is that type known as the below ground discharge and necessarily relies upon a patented rubber gasket to seal off any possible surface contamination from the well. In our case, sadly to relate, the seal had been omitted; consequently the water remaining in the enclosure along with all future seepage through the sand bag levee found its way into the distribution system, thus causing gross pollution of the supply.

Immediate notice was given to all consumers by messengers, over the telephone and through our daily paper to boil all water used for drinking purposes or in the preparation of foods. Incidentally our

daily paper never ceased to operate in those trying days and thus proved of great assistance to the Water Department in safe-guarding the health of our citizens and the thousands of refugees seeking safety in our midst.

In an effort to further safe-guard the supply, a chlorine machine was installed. This chlorinator injected liquid chlorine into the discharge of the pump against the pressure maintained on the distribution system by employing a small plunger pump operating through the chlorine injector at a head of 200 pounds. After making this installation we believed the whole trouble caused by pollution of the water had been eliminated, and began to catch our breath, but only for a minute or two, for we immediately realized that the interruptions in service that we experienced from one cause or another gave rise to another source of contamination. Because of the many open faucets and the few leaks in our mains, a marked infiltration of the muddy waters of the flood was noticed following every interruption in service. There was no means of adequately overcoming this situation as only one pump was available for supplying the system, and only one available power source for operating this pump. These conditions made it necessary to boil all water for domestic purposes for the entire duration of the flood.

DISTRIBUTION DIFFICULTIES

I have discussed in such detail the problems incident to obtaining and operating a source of supply, so that you may well believe that this was not our only problem, the solution of which ended our work. I must admit a source of supply was our major worry, and was given our undivided attention in order to reach at least a partially satisfactory solution; however, this was not our only problem. The unusual conditions existing presented many problems which otherwise would have proved to be only routine work. A boat patrol was necessary for the location and elimination of waste from services left open by fleeing consumers, and such damages to our distribution system as caused by the large boats plying the currents of the turbulent waters in our streets. This work was very difficult to accomplish, and would have proved much simpler with the aid of an accurate map of the entire system, which we did not have at the time. All valves and services had to be located by the guess and try method; which was very unsatisfactory.

PREVENTIVE MEASURES FOR THE FUTURE

We are drilling new and much improved types of wells, extending the entire well casings above the surface of the ground to sufficient height to avoid any possibility of contamination from inundation by flood water. These wells are equipped with turbine pumps of above ground discharge type driven by electric motors deriving energy from two sources, gasoline engine generator or city distribution system. The old partially submerged reservoirs will be replaced by a new and larger storage system; which will be constructed above flood level and thus maintain a small external pressure on the distribution system in case of interruption in pumping service. All secondary pumping equipment will be located in a new structure adjacent to and a part of this storage basin. The old system of pumping water directly from well to mains has, in so far as possible, been permanently protected from flood waters.

The distribution system has been accurately mapped with all mains, services, valves and hydrants located in a manner which readily permits relocation of any part of the system by measurements from any residence or other adjacent building. The making of this map required considerable labor, but has proved well worth the trouble and a great help at all times.

Confronted as we are with the constant hazard of floods, and the length of time these floods cover our city, we have endeavored to protect the water works from every possible angle, in order to lessen the seriousness of conditions resulting from this situation.

The importance of such protection can not be stressed sufficiently for you who have not been face to face with these conditions to realize the real seriousness of the situation, so I repeat this one fact: For the entire duration of the flood of 1927, three long months, it was necessary to boil all of the water used for domestic purposes, which under the conditions existing, created a hardship and an unnecessary hazard to countless refugees in our midst.

You, who are entrusted with the safe operation of water works systems, should safeguard your system now while your organization can function and material can be obtained, for in times of flood your organization is disrupted and material cannot be obtained. Make provisions for protecting the supply and your pumping equipment from the devastating forces of flood waters. Provide auxiliary power units capable of functioning regardless of existing conditions. Secure

some adequate method of maintaining a constant pressure on the distribution system in order to prevent infiltration of flood waters. These problems are for you to solve and you, who are subject to floods, should in all fairness to yourselves and your consumers see that every precautionary measure necessary is taken before the emergency arises. Do these things now, for afterwards it may be too late.

IDENTIFICATION MARKINGS ON FIRE PLUGS

THOMAS L. AMISS:¹ During my thirty years experience in water works operation, beginning as an inspector in 1901, I have carefully studied and observed the various results of the different methods employed by different operators and have tried to profit therefrom. It is a fact that no matter how long we have been in the service, I have found that one can always learn something by observation of and contact with the other fellow, and it was this thought that prompted me to accept the honor of appearing on the program when requested to by Mr. Porzelius, Chairman of the Plant Management and Operation Division of this Association. It was also the thought of the contact which one gets at these conventions that decided my membership in this organization. Therefore, I feel that if I can supply one thought that will redound to the betterment of the operation of water works this paper will have been a success.

Fire hydrants or plugs constitute one of the most important fixtures of the water works system. They supply possibly the only service in the department which of necessity *must* respond and I mean not fail, and ordinarily under conditions when the operator is excited or in an extreme hurry. In spite of rigid inspections, hydrants can be out of order and seriously affect the efficiency of the fire department. The marking of the hydrant, besides giving us information relative to capacities of the hydrants on certain conditions, places us in a position to know these capacities as we drive over the city or distribution system on inspection trips. In addition, in order to keep the markings correct, it will be necessary to check the capacities periodically, which in itself would serve as an inspection. In other words, we will be in closer touch with the hydrant than we would under ordinary inspection.

The fire department having studied the many angles and methods of fighting fire, desires to place the pumping engines at the closest

¹ Superintendent, Department of Water and Sewerage, Shreveport, La.

and most efficient location, thereby shortening the hose leads from the engine. Consequently the driver of the engine in his haste to make connection could know the capacity of the hydrant or plug just by looking at the hydrant as he drives by. He would select the plug most adaptable to size or capacity of the engine he is driving. Inasmuch as we have pumping engines ranging in size from 300 to 1,000 g.p.m. or more it would be wise to make the proper selection. I have seen engines of 1,000 g.p.m. capacity hook up to hydrants of less capacity, necessitating a cut down of the engine capacity to that of the hydrant, and of engines of small capacity connected to hydrants of greater capacity. Rarely is it possible to make the changes correcting this evil during a fire. Had the hydrant the proper markings, this would not occur unless the personnel of the fire department is inefficient. This latter defect, of course, can not be charged to the water department. The information can be secured by a study of the distribution system, but it is not practical for the firemen to equip themselves with this knowledge in that way, when the water department by study, tests and surveys can stamp the capacities of the hydrants on the hydrants at no great cost to the water department. It is the duty of the water department to have a certain amount of water available in certain prescribed territories, because of insurance rating requirements, but in spite of these requirements, there will be a plug or so in the territory that will not measure up to this standard. As I see it, the deficient hydrants, if marked can be avoided, if necessary, and no loss of time would be experienced by the fire department. Furthermore, from the standpoint of the fire department, marking the hydrant by painting rather than by numerals gives the driver a better opportunity than otherwise to discern the capacity as he drives by at a high rate of speed. I believe it would be impossible to read figures on the hydrant at night or even in the day time while driving past at a moderate rate of speed. The marking of the hydrant will also show the fire department that the water department is anxious to cooperate with them, which I think is a necessary action, whether the water works system is municipally or privately owned. They bear a very close relationship to each other. If the capacities or volume present at the hydrant are marked on the fire hydrant it will readily give the firemen upon arrival immediate information as to whether or not it is necessary to use the pumper. On many occasions only plug pressure is necessary and some times is passed through the pumper. I have had

considerable experience relative to the work of the two departments, as it was my duty when I first started out to attend fires, in addition to my work as Resident Engineer and make observations, noting pressures, location of pumping engines, length of hose leads and listen to comments from the crowd. This gave me close contact with the men and their attitude.

Let us consider now the information or results that the water department will get from the marking of the hydrants. You will obtain an A 1 inspection annually of your hydrants which is an absolute necessity. From the information gathered from the tests, your hydrant record can be enlarged by adding to the usual data, of location, kind, size and make, now kept, the static pressure and flow. We all appreciate the value of well kept records and in fact unless records are so kept, they are really a detriment to the department. I am a firm believer in a true record. The annual inspection, consisting of making flow test, physical examination and general condition properly recorded, will store for you certain information that will enable you after a few years to determine the condition of the interior of the pipe through the loss of volume. I appreciate, however, that other causes such as the extension of the system and the increased consumption in the close vicinity of the section in question can also produce the loss, but your meter registration will account for that loss. Creating an industrial section could cause it. However, in any event, the cause of volume drop being known, places one in a position to remedy it, whether it be by cleaning the main and restoring the full flow, which is a means of deferring reinforcement, or by direct reinforcement.

I believe that this practice will appeal to the National Board of Fire Underwriter Engineers as they believe in the Post Indicators on Valve. This in a like nature indicates the volume of water at the hydrant and can easily be verified. In further commenting on the value of records of hydrant pressure, etc., I have a report of the National Board of Fire Underwriters of 1911, giving the pressures on 34 hydrants scattered over a section of three miles square. In 1929, December 13, I had pressures taken on the same hydrants and the following is the result. The average for 1911 was 52.06 pounds and 18 years later 71.16 pounds, the least gain was 25 percent and the greatest nearly 100 percent or an average gain of 42 percent. If the above or any information on pressure represents any value

to the superintendent, then the flow or capacity marked on a hydrant over the entire city should at least have more, and as all of you know volume speaks the loudest.

METHODS

Two methods of markings present themselves to me. One is by painting numerals on the barrel of the hydrant about one foot above the ground indicating the capacity say, 500, 750, 1,000 and 1,500 g.p.m. The other, and the method I prefer, is to agree on a solid color, say yellow, for all hydrants over 1,500 g.p.m. and then paint the dome or hood of the hydrant any other color indicating the capacity, for instance a red painted dome would mean 1,000 g.p.m. are available, a green dome 750 and a blue dome 500 and under.

The hydrants of different colors could be seen at a greater distance than numerals could be read. In the event of reinforcements increasing the capacity, the hydrant dome can be painted to conform and decreased capacities can be handled in a like manner.

CONCLUSIONS

Since I have been studying the subject I am more convinced than ever that it is practical and efficient and upon my return home will proceed to work out the details of the survey to carry out this scheme. Honorable C. Bickham Dickson, the Commissioner of Public Utilities, under whom I have the pleasure of working has approved of this plan and is here to enjoy the convention. I propose to keep accurate records of my findings and to compile them. If this information is of benefit to any one, I shall be glad to supply it upon request.

On account of the fact that so much has been written on the location of hydrants, I do not think that I can add to what has been said. We are positive, however, that curb location is hazardous and much grief is experienced. My thought is to reduce the height of the hydrant and possibly re-design the top that they will offer no more obstruction, but less chances of being broken by trucks and the like. The cost of \$5.75 per hydrant is too high for maintenance and inspection and can be reduced.

The standardization of the fire hydrant by this Association is a step in the right direction and I hope standardization will spread to all fields of appurtenances used.

CHAIRMAN SWEET (Birmingham, Ala.): It is strange how men so far apart can come to the same idea. Mr. Porzelius asked me to present something to you before I open the discussion. We have a letter here from the Maine Water Utilities Association that is addressed to the American Water Works Association. It says:

"At a meeting of the Maine Water Utilities Association held in Portland, March 22, 1932, it was voted that the committee on fire hydrant markings of this Association present to your Association the following resolutions: .

"WHEREAS; it has been established that great benefit accrues to both the water department and the fire department to have fire hydrants marked to indicate their capacity and,

"WHEREAS; we believe that the time has arrived when steps should be taken toward a National Uniform Marking of fire hydrants and,

"WHEREAS; this Association in 1929 adopted a system for marking fire hydrants in the State of Maine, therefore be it,

"Resolved; that we urge the American Water Works Association to seek the coöperation of the various water companies in its membership to the end that a national code of colors for marking fire hydrants be established."

This follows out Mr. Amiss' general scheme. This is the allotments, or the marking, given by the Maine Water Utilities Association. The markings are to be determined by flow test by water department. Markings are divided into three classes, A, B and C, as follows:

Class A: Hydrants which have sufficient capacity to supply one or more pumpers, with 1000 gallons per minute.

Class B: Hydrants which have sufficient capacity to supply pumpers with not less than 500 gallons per minute.

Class C: Hydrants with insufficient capacity to supply pumpers of 500 gallons per minute.

All flow tests should show a residual pressure of not less than ten pounds.

The colorings: Barrels of all hydrants chrome yellow, for visibility.

Class A: Tops and nozzle caps green, green meaning clear or go, and denotes plenty of water.

Class B: Tops and nozzle caps yellow, yellow meaning caution, supply not too plentiful.

Class C: Tops and nozzle caps red, red meaning danger, should not be used if Class A, or B, hydrants can be reached.

The above colorings conform to traffic regulations; green meaning clear or go; yellow meaning caution; red meaning danger or stop.

The most durable method of painting, is to paint the entire hydrant

first with a good metal aluminum paint, then cover this with the proper colors.

Object: It is important to water department and to fire department to connect to a hydrant that will have sufficient supply. It gives the water department a valuable record of hydrant capacity and shows up the weak points in the water system for fire purposes. To most fire chiefs a hydrant is a hydrant. As a rule fire chiefs are not familiar with the size of the water mains or number of supply pipes, and do not know the hydrants of greatest capacity. With the colorings determined by flow test, fire chiefs know at a glance, good and bad hydrants.

It calls to other towns, if a uniform method is used, a fire chief is as much at home as in his own town. All of the above is of great importance to insurance companies.

MEMBER: Would it not be proper to refer that to the Resolutions Committee?

CHAIRMAN SWEET: That is what will have to be done with it. I will just pass this back to them. But has any one any suggestion to offer, for this is a rather interesting subject? It is interesting to me, at any rate. I never even thought of it. The fire chief over in our town knows where he can get lots of water and he knows what he wants. We cannot make it our business to tell him.

MR. GRINNELL (Grand Rapids, Mich.): I agree that this is an interesting subject because today with the speed and mobility of the modern pumper the fire chief has help from the surrounding town. He sometimes has more pumpers than he knows what to do with. Therefore, I think that a system of this kind would enable visiting firemen in any city to know where they could get their supply and how far they could go in drawing from it.

It is similar to the scheme that has been adopted in standardizing hose threads throughout the country so that fire departments from other cities can use existing hydrants to advantage. Another feature of this that occurs to me, because my experience is limited almost entirely to industrial fire prevention, is that the pumpers, or the hydrants, in a private plant may not be capable of supplying pumpers and if they do connect with the private hydrants they may over-tax it and then tie up the proper supply and take it away from the sprink-

lers. A suitable marking could warn the public pumpers not to attach to private hydrants. I am glad that this is going to be referred to the Committee so that we may have some action taken on it.

MEMBER: As an engineer of the National Board of Fire Underwriters I should like to say that anything that will assist the fire department in the knowledge of distribution systems, where they can get water, is the thing that we want.

Theoretically a fire department should know a great deal about the distribution system. They should have maps to show them where the hydrants are and what mains they are connected with, but practically that is not always the case. I think the painting of hydrants is probably more important in small cities where they have volunteer fire departments than in the larger cities, but even in the larger cities I think it has an advantage.

Some cities are already doing that to some extent. I think in the City of San Francisco they painted the hydrants as one and two pumper hydrants. The City of Trenton, New Jersey, designates hydrants as to pressure. Of course, there is one thing to be considered in this matter and that is that this will only apply to an individual hydrant. You can readily see that if the fire department came to a hydrant that indicated an adequate supply and used it, if they assumed that another hydrant on the same block, not far from that one, would give them the same supply they might be disappointed, that is, at the same time the other hydrant was being used.

From that point of view it might be wise to consider marking on the hydrants the size of main to which they were connected and that would give them some idea as to whether the next hydrant on the street would give the same supply. There are also cases of where there are two mains in the street and the hydrant is sometimes connected with the smaller main and the fire department does not always know it. They connect with a hydrant on one side of the street and get a rather poor supply, while if they connected on the other side they would get an ample supply.

J. W. GRAHAM (Portland, Maine): I happened to be on the Committee of the Maine Water Utilities Commission that presented this Resolution. It is the aim of our little Association in Maine to

have the cooperation of the water department and the fire department in order to get a uniform marking.

The New England Fire Chiefs have a Convention on the 15th of June and we are given to understand that they are to approve the markings of the hydrants as recommended in the Resolution.

CEMENT LINED CAST IRON PIPE

E. O. SWEET:¹ The Birmingham Water Works Company, a privately owned corporation, began the use of cement lined pipe in the fall of 1925. At that time we had a somewhat aggressive water and the plant was not so constructed as to readily control the water. In 1928 we remodeled the plant and then provided for the control of the pH value and now maintain this at about 7.2.

Mr. Gibson had written some articles on the use of cement lined pipe at Charleston and we became interested and looked into the subject and decided its use was advantageous. The first installation was made in October, 1925.

I happen to be Chairman of the Sub-Committee on cement lined cast iron pipe and have had a hard time trying to find out the experience of other users of this product. Naturally after the pipe is placed in the ground one does not get to see into it very often. In my case I have been a little more fortunate than most of you, due to the rapid growth of the City of Birmingham, in that it has given me an opportunity to see into a great many pipe lines, but such observations cover only a very short period of time.

We began the use of pipe with linings of a minimum thickness of about a sixteenth and a maximum of one-eighth inch. Later the thickness of lining was increased slightly and we now use pipe with thickness of lining in accordance with the tentative specifications.

Like all operators we are particularly interested in knowing to what extent tuberculation might be set up due to loose spots or cracks in lining or due to chipping of the lining when tapping or cutting the pipe. Another big item is the smoothness of lining after a period in service. One has no basis of comparison, in that when first received smoothness of lining is a mere matter of feel and observation, and as near as I can find out there is no definition of smoothness. So when you come to observe a pipe which has been

¹ Engineer, Birmingham Water Works Company, Birmingham, Ala.

in service, say two, three or five years, you have no means of comparing it with its original state.

I have examined within the past three years linings which have been in service three to five years and only recently examined an 8-inch line that had been in service thirty-one months. Of this latter line I examined about thirty-five lengths. There had been, so far as one could observe, no deterioration of the lining. It still retains a very smooth surface and there is absolutely no tuberculation. Check cracks which were undoubtedly present when the pipe was first put in, reappeared after the pipe had been stored temporarily before again replacing in service.

We were interested to know whether tuberculation had taken place below the lining along the line of check crackings, so we chipped off the cement lining and found no tuberculation on the pipe wall and, surprising to say, found the metal as bright as the day the pipe was cleaned before applying the cement lining.

There is no extra precaution taken in handling of cement lined pipe at our plant so perhaps some check cracking may have been caused in handling the pipe.

We have had some caustic water complaints. These have been confined in Birmingham entirely to dead ends. The only remedy we know of is that of flushing, daily, if necessary. The maximum period of flushing as I recall was about three weeks, after which no complaints were received.

In order to facilitate flushing of dead ends we tap our end plugs with two inch hole and forty-five degree a two inch pipe to the street surface controlling the blow-off with an independent valve.

We did have one interesting occurrence on a dead end line of cement lined pipe where the brass solder nipples of the lead connections used in service pipes attached to this main were very nearly closed up from a deposit that looked like lime. This deposit was not found in the galvanized iron service pipe or in the brass connections at the meter. I am not a chemist so I cannot tell you what the substance really was. However, it is the only instance of its kind we have experienced.

In all cases where I have examined cement lining as well as a 42-inch concrete pipe in service about two years it was noted that there was a thin gelatinous coating brownish in color, very smooth and of a greasy feeling to the hand. This coating on the 42-inch line was so slick that I had difficulty in crawling up into the line and

had to rub it off along the bottom of the pipe so that I could proceed up into the line. I examined at least 100 feet of this 42-inch concrete line and found it as smooth as the day it was installed.

The samples of cement lining taken from pipes which had been in service are all covered with this gelatinous coating, this coating when allowed to dry can be dusted off and the surface of some fifty samples examined were found with one exception quite smooth. The one exception sample showed the sand grains exposed to at least one-half their diameter.

We have at Birmingham a test connection installed in a force main between the pumping station and purification plant which we are watching with considerable interest. The force mains are unlined and carry at times a very turbid water, the velocity at times in this main is quite low and it was observed that there was a deposit of mud along the bottom of two of the cement lined pipes in the test connection, and that where this mud deposited that the cement lining was very rough. It was apparent that some chemical action was being set up due to the vegetable matter carried in the force main.

The conclusion of Mr. McKenzie and myself was that it might be possible in a force main carrying a very turbid water, not having sufficient velocity to carry mud and vegetable matter forward, that the cement lining might be attacked if mud was allowed to deposit and remain for a considerable period.

MR. McDOWELL: I confirm what Mr. Sweet has just said. Charleston, S. C., was the first to use cement-lined cast iron pipe and for the last ten years all its pumping mains and additions to its distribution system have been made with this kind of pipe, which according to our experience with sizes up to 24-inch, requires no more careful handling than tar-coated pipe of the same size.

In answer to the question as to whether these pipes can be dropped in the trench without injury to the lining, our practise is to drop the pipes off the truck using as cushions burlap bags filled with excelsior, roll to edge of trench, and drop into the trench. Where the bottom of the trench is in hard ground, the pipe is dropped on burlap bags the same as in unloading.

MR. SKINKER: We have been laying some cement lined pipe just this year in St. Louis, but I have not had sufficient experience to make any comments at this time. So far as I know it is perfectly satisfactory.

MR. PATTON: I have noticed that the cement lining in fittings has a tendency to come loose. I would like to ask Mr. McDowell and Mr. Sweet if they are buying their fittings with their cement lining.

MR. SWEET: We buy the cement lining in my case.

CHAIRMAN PORZELIUS: Relative to the effect of the cement lining coming loose, we cut our 8-inch pipes, the small pipes with a cleaver and we cut that pipe off just flush. The cement lining will not then break off back from the break. It will break practically even with the cast iron. In putting in tapping valves, cutting out the sectional pipe that contains the cement lining, the cement lining stays on that section of the pipe, except around the edges. Of course, the action of the bit in cutting through the metal will break off some of the cement lining.

MR. SANDERSON: Does the pipe ever leave the shop before the lining is put on? That is, does it have a chance to lie out in the open and rust? I do not mean large cakes of rust, but just a thin coating of rust.

CHAIRMAN PORZELIUS: Mr. Sweet, you have had more experience with that?

MEMBER: I do not understand that you mean rust on the pipe, will you make it clearer to us here.

MR. SANDERSON: The question was, in the process of cement lining of pipe does the pipe ever leave the shop after it is taken from the mold before the pipe is lined with the cement?

In other words, does it have a chance to become affected by the weather after it has gone out from the shop and what is the effect of that?

MR. McDOWELL: You mean in between making the pipe and putting the lining into the pipe is there an intermission of time sufficient to create a rust film? Is that your question?

MR. SANDERSON: Yes.

MR. McDOWELL: I would say that the normal time is sufficient to produce a rust film, but in the normal process of pipe making they are washed out in the normal checking operation. Pipes that are to be cement lined, of course, are not coated, for the coating would interfere with that and naturally we have what we call the first oxidized film form. When that pipe goes to the cement lining side it goes through the plant and through a grinding and cleaning process immediately ahead of the cement lining process, at which time a set of grinders are run through the inside of the pipe to break down any projections that might be in there that would tend to project through a lining. In that operation we remove any materials that would tend to interfere with the bond between the cement and the pipe itself.

MR. MOORE: In the coating of a cement lined pipe with any form of dip the result is dependent very largely on the process used. Our original effort at the American Cast Iron Pipe Company at Birmingham, Alabama, in developing the process was to allow the cement lined pipe to season for a sufficient length of time to get rid of the free water in the cement. The pipe was then placed in a heating oven, where we had accurate control of the temperature. We were able to raise the temperature of the pipe to 200 or up as high as 400 Deg. F. to find out where the best results were obtained.

We found that at approximately 350 Deg. F. the cement lining became affected by the temperature and began to crack. The tar coating was absorbed by the lining to such an extent that a flat surface effect was produced. A very good coating was obtained when the temperature of the pipe was kept under 300 Deg. F. and uniformly heated throughout its length. An examination of the lining indicated clearly that wherever there was a crack in the cement lining, which was other than a very fine hair line crack, the coating entered into the crack and went through and spread out between the cement lining and the pipe.

In the development of the process we have come to believe that the coatings of cement lined pipe should be done without heating the pipe. The coating should be heated and applied directly to the inside surface of the lining, either with a brush or with a spray, or a floating process with the pipe revolving, not necessarily fast enough to produce a centrifugal force process, but rather to give a uniform distribution of the coating.

You will find a nominal penetration of the coating into the cement which will retard, if not completely prevent the undesirable lime effect in the water where you do not have sufficient flow or circulation through a new line.

MR. BANKSON: While Mr. Moore is on his feet I would like to say something. We had some experience with cement linings of large pipes during the hot weather and we were troubled with the pulling away of the cement lining from the pipe. I should like to hear some discussion on that point as to remedies or how serious it is and what can be done about it.

MR. MOORE: What size pipe are you speaking of, specifically?

MR. BANKSON: I believe it was 36-inch.

MR. MOORE: Our direct experience has been confined to 24-inch sizes and under. I am familiar with the experience in the industry with the larger sizes and these sizes do present a difficulty that does not seem to be in as intense a form in the smaller sizes. Our experience with 24-inch pipe has been entirely satisfactory. We do not seem to have encountered the loose spots to an extent sufficient to produce any trouble. A loose spot develops when the cement mortar is not properly bonded to the pipe. It is generally assumed that the cause is either a too thick lining or a too rich mixture, or some of both. A thick lining increases the problems of loose spots because the cement mortar in setting and shrinking has within itself sufficient strength to pull away from the wall of the pipe.

The lining of the larger sizes of pipe with cement is an art. The art of making a good lining involves the proper selection of materials and the careful mixing of the mortar to give a mixture with the minimum shrinkage. Thick enough, but not too thick; rich enough, but not too rich, all with the idea of avoiding loose spots on the one hand, and excessive check cracking on the other.

Troubles from loose spots or check cracks are unheard of once the pipe is placed in service, so that the struggle to avoid them is a striving after an ideal physical condition in the lining prior to installation, rather than the correcting of a defect or trouble as developed in the product in service.

USEFUL GOVERNMENT DOCUMENTS

A. F. PORZELIUS:¹ It is the purpose of this paper to bring to the attention of our members, the large amount of research data which has been compiled by our Government. No doubt you are all more or less familiar with some of this data. However, I question if but few realize the enormous scope of the work which is done by our Government in compiling such data.

The United States Government employs thousands of scientists who are continually engaged in making researches and investigations in all phases of human endeavor and the results of their research work are available to anyone at a very small expense, as the United States Government publishes such information at the cost of printing.

In this paper I will deal only with those subjects which are of direct interest to waterworks superintendents and their associates, and even at that, due to the large amount of information which is covered in the Government publications which are of interest to us, I can touch only the high spots and bring to your attention the general reference publications which are issued by the United States Government Printing Office so that you may follow these up in case you desire to investigate any particular subject.

The Superintendent of Documents of the United States Printing Office at Washington issues various price lists of Government publications, and from these price lists the information can be obtained relative to the cost of the book or paper which gives the detailed results of any particular research or investigation. I will discuss these price lists briefly, pointing out wherein they may prove of value to the water works fraternity.

Price List 10, Laws—While we are all interested in the laws of our country, the particular reference to which I wish to call your attention in this document is that of health laws.

Price List 15, Publications of the United States Geological Survey, Geology and Water Supply—From this list may be obtained information which is of great value, since information can be furnished on artesian wells, ground water supplies, surface supplies and stream flows throughout the country. Of especial interest is Water Supply Paper 596-H, Notes on Practical Water Analysis, and Water Supply Paper 496, The Industrial Utility of Public Water Supplies in the United States.

¹ Superintendent, City Water Company, Chattanooga, Tenn.

Price List 18, Engineering—Of particular interest to waterworks men who reside in such portion of our country as are subject to earthquakes the question of earthquakes has been investigated and considerable information prepared.

Price List 21, Fishes—A number of waterworks having impounding dams throughout the country can obtain much valuable information regarding the stocking and care of fishes for such reservoirs. You can even find out how to take care of the little goldfish, and what waterworks superintendent has not had the problem presented to him of the effects of chlorine or some other substance in killing of some consumers goldfish?

Price List 42, Irrigation, Drainage and Water Power—Considerable information is made available in the papers covered by this price list relative to underground waters and hydrology of our western states.

Price List 43, Forestry—For superintendents interested in the reforestation problem, the Government has much valuable information.

Price List 48, Weather, Astronomy and Meteorology—All water works design must be based on the best of water supply available in any locality and this publication makes available rainfall data covering a great number of years, also climatological data, flood data and studies of evaporation losses.

Price List 51, Health—The question of water purification, pollution of streams and sanitary engineering in general is covered in great detail. A large mass of information is also available on water borne typhoid fever epidemics.

Price List 63, Navy—Considerable information available relative to pumps, boilers and other phases of mechanical engineering.

Price List 64, Standards of Weight and Measure—A standard can be obtained for practically everything utilized in the operation of waterworks.

Price List 70, Census Publications—This makes available statistics of population and other matters which are necessary in order to plan for the future of any water supply.

In addition the Bureau of Standards has issued catalogues of publications, one of which is Circular of the Bureau of Standards No. 24 and another the Supplementary List of Publications of the Bureau of Standards, July 1, 1925 to February 28, 1930. The subject of electrolysis and pipe corrosion is covered in great detail and

there are many other subjects which are of value to waterworks men.

The topographic sheets which are prepared and issued by the United States Geological Survey are also of great value as these give the complete topography for practically 40 percent of the area of our country. A map showing the areas which have been surveyed can be obtained by writing to the Director of the United States Geological Survey at Washington.

These price lists should be in the library of every waterworks superintendent, since they make available to him this vast source of information which the Government has compiled.

It will be of interest to all waterworks men to know that the Bureau of Standards is constructing a new hydraulic laboratory for the purpose of making hydraulic tests of all kinds, and there will no doubt be much interesting data published when the operation of this laboratory gets underway.

INVENTORY METHODS FOR YARD STOCKS

C. J. ALFKE:¹ Yard stocks include pipe, patent connections, valves, hydrants and fittings larger than 1 inch. As a rule there is little attention given to the manner of taking an inventory or the supervision of the actual taking of inventories because it is not fully appreciated or considered just what part the taking of a physical inventory plays in the system of internal checks set up around the handling of materials to prevent loss or waste.

Some of the avenues of waste in the handling and storing of materials are:

1. Ordering material not required.
2. Ordering excessive quantities of material required.
3. Accepting material that does not come up to specifications due to improper inspection of materials received.
4. Materials being issued or transferred and not reaching the job, let us say through dishonesty.

The taking of the physical inventory is the final one of a series of steps necessary properly to control waste through materials. The steps essential to the control of materials are as follows:

1. Proper system of purchasing, namely, the authorization of certain parties only to issue purchase requisitions.
2. Purchasing done by Purchasing Department, copies of purchase

¹ Comptroller, The Hackensack Water Company, Weehawken, N. J.

orders being sent to the Store or Receiving Room and Accounting Department.

3. An adequate system of checking materials received against Purchase Orders as to quantity, condition and quality.

4. Proper system of storage.

5. Proper system of issuing material on requisitions of those authorized.

6. A physical check either continuously or periodically of materials on hand and comparison of same with stores records.

The best materials control system is not adequate, if physical inventories are not taken continuously or periodically for the purpose of comparison with stores records. Perpetual inventory records do not eliminate the need of a physical inventory. It is not uncommon to have material stored at pumping stations or branch offices removed from the main yard where the individual in charge is an operating man and the responsibility for the materials is only a small part of his duties, as the work is not sufficient to require the full time services of a store keeper. Under such conditions there is very apt to be more than one man looking after materials, and Issued and Received Tickets may not be made out consistently. Differences between physical inventories and book inventories should be investigated where there is no justification for the difference, viz.: a difference between physical inventory and stores record of 12-inch valves should be investigated to determine the reason, whereas differences in valve boxes and curb boxes and parts for same would be expected and would not be investigated unless too large.

Physical inventories may be periodic or continuous.

The term Periodic Inventories ordinarily refers to inventories taken at the end of specified periods for the purpose of the closing of the books and adjusting book records.

The term Continuous Inventories ordinarily refers to the continuous inventorying of some materials daily or weekly or monthly all though the year covering all material possible several times a year. Continuous Inventories are taken where perpetual inventory records are kept. The books are adjusted once a year.

I have found that the taking of a Physical Inventory each month of some of the yard stock and covering the stock about twice a year works well. Book records are adjusted when required after investigation of differences.

Physical Inventories should be taken more often of active ma-

terials than of inactive materials to facilitate investigation of differences, that is, it is easier to investigate a difference over a six months' than a year's period.

No matter what method is used in taking an inventory, a well kept yard helps considerably. The storing of material with some thought, segregated by sizes and types in an orderly manner, actually saves space and considerable handling, in addition to being an aid to taking an inventory. The steps in taking an inventory are as follows:

1. Preparation of yard for inventory.
2. Instructions for inventory taking.
3. Inventory taking.
4. Listing of the inventory for checking with book record.

1. *Preparation of yard for inventory:* The materials should be looked over by the Storekeeper and (a) obsolete and junk material should be separated from the active and good material, (b) all material should be brought out of corners and inaccessible places and put with the material to be counted, (c) all material should be laid out in neat orderly rows or piles by sizes and types to facilitate counting.

2. *Instructions for inventory taking:* Experience indicates that it is best not have the general storekeeper or any of his assistants take the inventory. It is not necessary to shut down to take inventory. Therefore, the assistants and clerks in the stores department are needed to carry on the day's work. Individuals not connected with the stores department should take the inventory. The individuals who do the counting of the materials should be instructed just what they are to count, what record should be made, to whom the record should be turned over when it is finished and should be told who is in charge of the taking of the inventory and from whom they take their orders.

3. *Inventory taking:* We are familiar with the method of taking inventory which involves only the counting of materials and listing it and then turning it over to the General Storekeeper or the Comptroller. In this system of just counting the items and jotting down the quantities on a pad, items are overlooked and the movement of material in and out during the period of inventory taking confuses the count and subsequent check with book records. Also the men doing the counting are very apt to be interrupted and unable to determine where they left off. This method will not bring the best

results especially if the material in the yard is not stocked in an orderly way for inventory taking.

What is known as the "Inventory Tag Method" works out as an accurate method of inventory taking.

The steps are as follows:

a. After the material has been arranged in an orderly manner for counting and instructions have been given to the counters, the counters are supplied with tags. These tags are numbered and are given to the counters to be placed on each type and size of material in the yard to be counted. Some method must be used of fastening a tag to one piece of each type and size material to be counted either by wire or by cord. The tag (dimension about 3 and 5 inches) provides for enumerating on same, size and type of material, quantity, individual by whom counted and the date. The individual in charge of the inventory should note the numbers of the last Issued and Received Tickets for material going out and coming into the yard before the count is started. Movement of stock while the inventory is being taken should be kept down to a minimum by informing those who usually draw stock that inventory is to be taken.

b. After the tags have been placed on the materials, the counters assigned to the various materials, count the material and fill out the tags. The tags are left on the material and if found necessary a check of the count can be made. When the individual in charge of the inventory is satisfied with the count, the tags should be collected from the material and the items listed after the tag numbers have all been accounted for. Movements of materials going out and coming in while the inventory is in progress should be noted on the tag and such notations should be considered when arriving at total units from tag.

4. *Listing of inventory for checking with book record:* The tags should be listed by types and sizes of materials. The number of units should be listed and columns should be provided for unit prices and extensions if it is desired to price the inventory. If materials are carried on books at cost and inventoried at cost, it is only necessary to list the number of units of each type and size of material. The units as per Inventory Listing should be compared with units as per Stores Record Cards and where it is necessary to correct the book records inventory adjustment slips should be made out and books corrected after proper investigation of reason for differences where differences are unwarranted.

In closing, I should just like to say that probably a large percentage of waste in industry can be accounted for through the handling of Pay Rolls and Materials and an accurate physical inventory may very often indicate the necessity of investigating materials handling policies.

MR. MICHAELS (Orlando, Fla.): One statement Mr. Alfke made was that, in the comparing of their inventory if they found it out of balance with their book records, that is, the larger items of stock that would normally be in the yard, they would do certain things. Now what do you do? Do you go back over the jobs that were done and try to make the superintendent give a proper order for it and make an adjustment on the books?

MR. ALFKE: We usually go back over the jobs that we have done and try to determine if we can assign it to a job that it belongs to. It is only after an exhaustive search that we write it off.

MR. BERRY (American Water Works and Electric Company, New York, N. Y.): I should like to ask Mr. Alfke if he has any method for the distribution of stores. I think that has a direct bearing on inventories. How is your material distributed?

MR. ALFKE: We have, but I touched on it lightly because my paper covered only inventory taking. Work orders are issued for all our jobs, copies are sent to the accounting, the storage and the operating departments. Our storage department cannot issue stores without a copy of a work order and we cover it that way. Does that answer the question?

MR. BERRY: Yes, it does, except for items that require coming out of stock for maintenance. How would you cover those?

MR. ALFKE: They do not usually get into large items. We have standing work orders for maintenance items, and, as I say, on the smaller items we do not expect to get down to the last units.

MR. BERRY: As a matter of added information along this line I might state that we charge everything to the individual and nothing to the job. All the foremen ask for the material that they require for stock in their own name and then they are responsible for ac-

counting for that entire stock that they withdraw. They in turn distribute it into the various job orders or for maintenance. They are responsible for that. We have found that that is an excellent way to carry even your smaller parts down to a very close check at the end of the year and your physical inventory is only once a year.

MR. ALFKE: That is true, but you are only making that man do your adjusting rather than doing it for yourself. In my opinion that is what it amounts to. In other words, if he cannot account for all your stock by usage he will account for it some other way.

MR. BERRY: What other way would he account for it? He is signed for it. If he deliberately loses it he has got to say so. It is charged to him and he must account for it.

MR. ALFKE: That is right, unless he can cover it up in some job which I think they would do. Do you see what I mean?

MR. BERRY: No, I do not.

MR. ALFKE: Suppose a man goes out with some service material and he has to do a repair job. Suppose he goes out with forty feet of copper tubing and suppose he can repair the job with three or four feet and he does not bring back the balance of the tubing. He might put down on this ticket that he used the forty feet. That is an exaggerated case, but I just want to convey my idea to you. In other words, you are making him do the adjusting rather than doing it in the office yourself.

MR. GRINNELL (Grand Rapids, Mich.): In the matter of stock inventory, we have what is known as our stores office which is not physically connected with the stockroom, where all the records are kept, and then we have our storekeeper in the stockroom. We generally have those men from the office take that inventory and they have assistants whom they direct to do that and not the man actively in charge of the stock. Is that the idea that you intended to convey? It is not the man handing it out and actually taking the records.

MR. BERRY: How do you handle the question of your bin stock for facilitating the inventory?

MR. ALFKE: We assign space to each type of fitting, and then we cover it at the same time and in the same way as the yard inventory.

ORGANIZATION OF WATER DEPARTMENTS FOR EMERGENCIES

J. S. DUNWOODY:¹ We endeavor to organize a water works for the unforeseen occurrence so that immediate action can be had to reestablish normal service. The average person thinks of the distribution system first when consideration is given to a possible interruption in service; so let us first discuss emergency measures to correct failures in this branch of a supply works.

The failure of a rising or force main usually gives the greatest concern. All valves on such a line must be in working order and work freely, not only the force line valves, but all valves controlling take offs. Such valves should be installed in pits or vaults to permit of easy access. They should be operated at least once a year, and if gear operated, careful attention should be paid to greasing. A sheet metal cap to cover freshly greased gears protects against street dirt and water, and prolongs the usefulness of the lubricant. An occasional application of penetrating oil on the stem at the stuffing box keeps the packing soft and aids materially in free operation.

Being assured that the valve control is in free working order, the next step is to be organized for quick operation. The extent of such preparation is entirely dependent upon the size of the system, but the smallest of supply works should have some workable plan for immediate action to correct a main failure.

The emergency preparations as they exist in Erie may offer some suggestions to the operators of plants of similar size or smaller, but to the operators of larger works they may sound somewhat crude.

The Repair Shop, where all emergency calls are directed, has in connection a six room apartment. This apartment is occupied by a regular foreman and his family. It is the duty of this family to receive all calls when the Repair Shop office is closed. This insures such calls getting prompt attention. Apartment rent, light and heat is the compensation for this service.

All foremen, of which there are four, are provided with direct line telephone service in their homes, and each man in turn is subject to call after regular shop hours. All calls, regardless of how trivial, received at the Repair Shop are immediately relayed to the foreman

¹ Superintendent, Water Department, Erie, Pa.

on duty, and he responds with the emergency truck for investigation. If his investigation reveals the necessity for immediate repairs, by the use of a way-side phone the emergency crew is notified and a truck dispatched to get the men on the job. If an emergency call indicates force main trouble, the Shop Foreman must respond for investigation whether or not it is his regular night on duty.

Consideration has been given to a full time night emergency crew, but we are not convinced that such an expenditure is warranted in a city of our size (120,000 population with 240 miles of mains). My belief, however, is that the time is not far distant when such an arrangement will be fully justified at Erie.

The emergency truck is fully equipped at all times. A careful check is made from time to time by the distribution system superintendent to see that everything is available for investigation and repair of every kind of a failure. This truck is equipped with an electric valve operating device. This is a slow acting electric drill built to fit the valve key. At every intersection where a large sized force main valve is located, an electric plug-in station has been provided to furnish power for electric valve operation. With this device a 30-inch valve can be closed in less than three minutes.

A detailed print of pipe lines at every street intersection, drawn to a fairly large scale, along the line of force mains is a part of the emergency truck equipment. Each foreman is provided with a similar set of prints.

We have also an air drill as part of a portable air compressor equipment for use in operating large valves. With these two types of equipment available for operation at different locations, the closing down of a section of large main can be accomplished in a very short time.

A complete stock of repair parts for all sizes of valves and pipe should always be available in a well regulated repair shop yard, so that restoration of service and fire protection can be made with the greatest possible speed.

The complete inter-connecting of a distribution system, together with a proper valve distribution, will always permit by-passing a supply around a main failure, thus disturbing the least number of consumers during the period of repair.

This leads me to the thought of other types of emergencies in a water supply system which are fully as important as a main break, but must be provided for in a different manner. I shall mention

but a few at this time, and will not attempt to elaborate on any of them.

The failure of a feed water pump in a boiler plant would result in a serious tragedy, so duplicate pumps are always provided. But is this provision sufficient to assure uninterrupted boiler operation? Every boiler should be provided, in addition to the regular duplicate boiler feed equipment, with an injector fed from a water source entirely separate from the regular boiler feed supply.

Every steam operated plant should have a fully belted steam header, carefully cross connected and valved so as to provide a full two-way steam supply to all engines.

A filtration plant dependent upon the hydraulic operation of valves should have two distinct sources of pressure water to assure uninterrupted operation.

Pumping plants electrically actuated should be provided with duplicate power leads to assure continuous operation.

I could go on and mention many more operating emergencies where a failure could lead to serious embarrassment.

These last enumerated emergencies are of a different character from those that might develop in a distribution system, but an organized effort to prevent interruption in any branch of a water supply must be the constant aim of a properly developed operating force.

MEMBER: How many men do you have on call at all times, that is when your regular office is closed?

MR. DUNWOODY: I stated that we have four foreman. Each foreman alternates at night and he is subject to call from the time he leaves his regular work until the next morning and he has available for emergency call, if he finds work necessary, a crew of five men that can be called on short notice and go to work. That is our regular leak crew and they are all subject to call at any time of the day or night.

MR. GRINNELL: I would like to ask Mr. Dunwoody another question: are those men there alternated through the whole force? I suppose that one crew will be on call for one week and another crew next week, etc.?

MR. DUNWOODY: It is night about.

MEMBER: Is that so? I was interested in that. We have a similar case in Grand Rapids and we work that, especially week-end work, on a five day week in our water works. We have done this since last August. We did it because we run into the problem that from Friday night until Monday morning they want to be off, and so we run them on alternate week-ends and that way we always have a crew on at night. Or rather, we do that and we also have a crew on at night.

MR. DUNWOODY: It is night about for each foreman right straight through the week.

CHAIRMAN PORZELIUS: For Mr. Dunwoody's information I might say that in Chattanooga we have 125,000 people and we probably supply 145,000. We maintain a man on continuously at night. His job is to take care of all emergency calls and to wash all of the automobiles. So sometimes the automobiles are not washed. Of course, if the break or the emergency requires more than one man, as soon as he has made an investigation he has certain other foremen that he can call on and we are fortunate in having quite a regular number of our leak crew men located in one section. When the foreman gets a call he can get the men together and by the time they are ready the truck will pick them up. We have someone at our garage and storeroom continuously all the time.

Our telephone calls are received at the office during the day, even emergency calls in our engineering department, but from five o'clock in the evening until seven o'clock in the morning all calls go to the storeroom and garage.

MR. DUNWOODY: I think the provision of our department in connection with our Repair Shop operation possibly relieves the situation a bit. Foremen get relief from service when not needed, yet there is someone available to take all calls at the Repair Shop during closed hours. Each foreman has his regular night during which he is responsible for the investigation of all calls.

I might add that I personally feel that the time is not far distant for Erie when an emergency crew will stand by all night. If it does, I presume that it will be a crew of at least three men, so that the

normal valve operation would take place when the crew went out, and they would not have to wait to call in all the additional men.

MR. THOMPSON (Omaha, Neb.): The speaker mentioned the valves that had electrical connections. I would like to ask just what type of connection that is and under what method you would pay for the service?

MR. DUNWOODY: We have provided by the power companies a lead down the nearest telegraph or telephone pole, to the valve box. There is a plug-in connection under lock on which we pay the minimum service charge of seventy-one cents a month.

MR. THOMPSON: Have you a large number of such connections?

MR. DUNWOODY: We have one at every large connection in the force main system. I think the totals are eight or nine throughout the city, just on the force main for the operation of a large valve. If we wanted to carry a rig for operation we would much prefer to use the air drill than the electric drill, which is something that has been added to our equipment since the electrical arrangement was provided for.

CHAIRMAN PORZELIUS: Is there anyone else that would like to discuss this paper?

MEMBER (Indianapolis, Ind.): I would like to say that in Indianapolis we have carried the emergency plan beyond the ordinary night interruptions and have considered emergencies that might occur in the shape of calamities. Each department head was asked to outline what might happen in his particular district or in his department that might cause an interruption in service to the whole city. We have considered what we would do in the case of a flood. How it would affect our system. What we do in the case of a fire at each of these stations, or a tornado, or what have you. We were trying to anticipate unusual things and plan for them in advance, in addition to the ordinary emergency work.

In Indianapolis we have one man on duty to answer calls that come in at night, one foreman who does not rotate. He is not on duty. He goes home and calls that are unusual are sent in to him and if he

has to get out at night why he has a crew subject to telephone call and they go to the source of the trouble. Probably that results in shutting off some of the difficulty and they are ready to stand by until morning and then the regular day crew goes out and takes care of the trouble. But I just wanted to bring up this extraordinary emergency consideration which is sometimes neglected until after the thing has happened.

MR. SKINKER (St. Louis, Mo.): I want to offer a suggestion to those who are contemplating or have emergency trucks for use in night calls. We have a truck, a three ton Dodge, fully equipped with all of the necessary wrenches and tools that will be used and in addition to that right back of the cab we have installed a little 800 watt lighting plant. It takes up very little room and it increases the efficiency of your night crews probably fifty to a hundred percent.

MR. GRINNELL: We have tried out the acetylene plant with the tank and a special lamp on it. In previous years they used to use lanterns and candles, but we find the same thing as Mr. Skinker that the men do have much better working conditions and work more easily when they are on the job.

CHAIRMAN PORZELIUS: In the providing of lighting for emergency jobs we find that is a very necessary thing and every emergency truck should have some provision for it.

MAKING WATER WORKS PROPERTIES ATTRACTIVE

O. Z. TYLER:¹ As man is known by the company he keeps, better yet by the way he keeps his yard. Obviously this may be also applied to plant grounds. A lawn instead of a desert is often more indicative of the owner's brand of citizenship instead of his veto.

Manufacturers, public service corporations and others are realizing more and more that attractive, well kept property, not only indicates a desire to serve the community, but creates a better morale among the employees and pays direct dividends in good citizenship.

Beautification depends a great deal on local conditons, that is, climate, rainfall, moisture of ground and richness of soil. We have

¹ Superintendent, Electric Plants and Water Department, Jacksonville, Fla.

learned in Jacksonville that attractive grounds can usually be created and maintained without excessive cost and without the assistance of a professional or landscape architect. Two men are employed to create and maintain Jacksonville's water works grounds. Men on this kind of work should be experienced in the working knowledge of soil, plants, shrubbery, etc. and also possess initiative for laying out and nursing new designs and forming the various geometrical shapes into which beds may be made.

There is no systematic order of procedure that can be applied to plant grounds. It would be unwise to expend too much energy towards beautifying plant grounds until sub-surface conditions as pipes, drains, conduits, etc. are fairly well fixed and even then it is good practice to keep flower beds and shrubbery away from tops of pipes, conduits, etc. It is not until very recent years that our water works grounds have not been almost constantly dug and re-dug, associated with the multiplicity of changes and extensions of sub-surface conditions.

It is, we believe, not good policy to make parks or amusement attractions, as miniature golf courses, which in one instance has been done in Jacksonville.

Over-beautification should be avoided; winding sidewalks and proper lighting give an attractive nocturnal set-off.

Reservoirs are usually on water works grounds. Their tops protrude above the average surrounding ground level, thereby having a slope around the rim of the reservoir. On top of reservoir is about 2 feet of earth and many experiments and much care has been exercised by us to prevent these slopes from washing. We find the most satisfactory method to prevent this condition is as follows:—Let the angle of the slope be not less than 45 degrees, build low 8-inch common brick walls around the rim of reservoir with overflows (size 4 inch by 5 feet, in walls, spaced about 70 feet apart, construct concrete down chutes from each overflow and lead water to drains or manhole, etc. Cultivate as dense a turf as possible, grade the top of reservoir turf not less than 1 percent. Our theory is to increase the runoff on top of the reservoir to minimize the ground seepage or excess which makes the earth soggy and undesirable.

Elevations and grades present serious problems and when fills or excess earth are on hand grades should be given in view to ultimately arrive at higher uniform grades to streets, sidewalks, etc. It is also well to fill all ground depressions first and when earth is upset by

excavations to retrieve and later uniformly distribute the richest earth over proposed planting areas.

We find that spray sprinklers are efficient and allow night-time watering.

The kind of flowers, shrubbery, trees, etc. depends mostly on location and climate. However, it seems that a goodly share should be hardy plants and winter plants so as not to render the grounds too barren in cold weather.

When the appearance of an expanse of several acres is to be cultivated, obviously lawns predominate and are set off by clusters of enduring plants and shrubbery, with flower beds scattered here and there, but not overdone.

Foundation planting, that is planting applied to shrubbery, vines and herbaceous plants (rarely including small trees) placed along the base of a building, has a most desirable effect. Appropriate sidewalk edging is also pleasing. A small bush named "Althnanthera" for sidewalk edging has merited considerable admiration from some of our public.

Florida is naturally fortunate in having an abundance of variegated flowers, trees and shrubbery, a few of which are, zinnias, petunias, phlox, gladiolas, calendulas, verbenas, snap dragons and poinsettias. The above mentioned plants are ideal for foundation planting. The elimination of diverse colors and forms tends toward unification, or at least simplicity, which is also desirable in itself.

In actual practice the most powerful means of securing results lies in adopting a clear-cut motive and adhering rigidly to it. It is desirable, but not easy to bring together many various elements into one harmonious whole. The beginner should not be discouraged if he is unable at first to make his plant grounds as attractive as others, but with the experience and effort a satisfactory solution may be reached even in extremely bad conditions. Care should be taken that the designs and layouts are not overdone. The person in charge can gain variety in the following ways, amongst others: topography and ground forms; grading land; the number of trees, shrubs and flowers at his disposal; the various combinations in which they may be grouped; the use of water, still or flowing and the changes of season, weather and the hours of the day.

The design may be defined as the orderly arrangement of all the elements in the area. The best design is that which achieves the greatest degree of order and the poorest design is one which shows the

maximum of disorder. The most direct means of gaining order is to increase the number of agreements among object. If the objects are all the same size, form and color much has been gained on comparison with grounds in which the objects are of miscellaneous colors, size and form.

Development of good lawns should be paramount and lawns are rather difficult to establish where the grounds are full of trees. We have had fair success by using Centipede grass in shady places, which is a cross between Bermuda and St. Augustine grasses. Silly ornamental features as cast iron statues of local heroes, antiquated artillery, etc., are not becoming to waterworks lawns.

The repair of injured trees, the removal of crowded specimens and the scientific preservation of those remaining should be the next undertakings.

Manhole tops, valve jackets, catch basins, etc. should be brought flush to grade. Necessary projecting pipes or well casings can be camouflaged with rock and cement in such shape as to appear as some medieval fountain.

Arbor vita hedges about 6 feet high planted around rims of open reservoirs have proven attractive and also serve from a sanitary viewpoint in minimizing dust and papers from blowing into reservoir.

Maintenance is even more important than the original layout of the grounds, as they must be kept clean and in good order at all times. Moreover, it requires much larger moral qualities to pursue the daily drudgery of maintenance and to keep every thing always spick and span.

LOCATING UNDERGROUND STRUCTURES AND LEAKS

W. S. PATTON:¹ For locating underground structures of a water plant nothing can take the place of accurate maps, constantly kept up to date. Gone are the days when the only record was the memory of some old trusted employee who could recall the location of every main, valve box and service line. In spite of the most painstaking efforts to keep accurate records, however, it sometimes happens that a map is at fault so the acquisition of pipe locating and leak locating devices is a good investment on account of the labor saved.

Probably the most convenient device for locating a pipe line, where the two ends can be reached, is the wireless pipe locator. This

¹ Manager, Water Works, Ashland, Ky.

appliance has been on the market for so long and is so well known that it is not necessary to describe it. Another device in common use is the dipping needle, which is useful in locating valve boxes when covered over.

The stopping of leaks is an important phase of water works operation because when water is leaking money is wasting. Water plants which are unable to account for more than 80 per cent of their pumpage could advantageously start a leakage investigation. This investigation should cover slippage in meters and leakage at reservoirs as well as in water mains.

Fortunately we have several ways of detecting leakage in the distribution system, the most thorough being the pitometer survey. Under this plan certain sections are isolated and the water is measured by a pitometer. In case of an excessive demand the field of investigation is narrowed until the cause is ascertained. One advantage of using the pitometer is the ease with which large meters can be tested in place. If it is considered good practice to have the books of a water plant audited, it is equally good practice to investigate condition of mains and meters.

A convenient method of locating leaks, when the approximate location of the leak is known, is by use of one of the leak locating devices constructed upon the principle of the microphone or seismograph. Another device, consisting of a metal rod, with metal disc attached to one end and enclosed in a telephone receiver with a few inches of the rod protruding is an almost indispensable tool.

Leaks under paved streets are a common occurrence and it is not unusual to have the water show up at points two squares away. In event the water plant is not equipped with leak locating devices a simple way of finding the exact location of the leak is to drill a series of small holes through the paving at points over the main. The volume of water flowing from the holes and the sound detected on an iron rod inserted in the holes are reliable indicators of the location of the leak.

If water works operators knew at all times what was taking place in their distribution system a lot of us would not sleep soundly at night. One morning a short time ago the pressure in the mains dropped from 85 to 50 pounds. After considerable effort we found the leak. A 4-inch main had burst under a paved street and had hollowed out a space large enough to hold a moving van. Thanks to the work of an honest contractor the concrete base had held intact.

For the account of the following incident, which happened at Auburn, N. Y., I am indebted to the Pitometer Company: A horse drawn fruit peddling wagon was gently meandering down the street when the driver was rudely awakened from his cogitations on the dearth of bananas by the sudden drop in horseflesh, as the macadam street collapsed under his motive power. Investigation showed that a service leak had gradually undermined a considerable area of the street, which was apparently held in place by the grace of God and the arching action of the macadam until conditions were just right to catch a victim. No pitometer survey had been made at this time. It started two weeks later.

MR. GEAR: (Holyoke, Mass.): My friend Mr. Patton was telling me last evening that he was going to read a paper on this subject. I foolishly told him about a little trouble we had some years ago. I do not know if my memory will be good enough to give you the details, for that was 30 years ago.

Before the Holyoke Water Department became a municipal department it was owned by a private corporation which had laid cement lined pipe in some of our streets, but when the City of Holyoke took over this department all the cement lined main pipes and all connections going into the different buildings were left in the ground.

It was in the month of February with 2 or 3 feet of frost in the ground that a leak appeared going into the cellar of a building. At that time we did not have the different devices and instruments used in locating leaks that we have to-day. All you could do was to go out and locate them, so we dug outside the wall of said building and we found a $\frac{1}{2}$ -inch lead pipe discharging water, we bent it over and waited for developments. The next day another leak appeared in another building, so we dug down and found a $\frac{1}{2}$ -inch lead pipe with open butt. Then we knew that city water was getting into the cement lined mains, and there was about one mile of such mains in the different streets, so we were up against it. Next a leak appeared in the center of one of our Main Streets, so we dug down and discovered that the water was coming north from where we had dug. We made another hole one thousand feet north of our first and discovered that the water was coming south. We dug another hole center way between first and second and found that the water was coming north, so we came to the conclusion that the leak was within

that 500 foot section. We took 300 feet of $\frac{3}{16}$ -inch wire, threaded the end and connected a tin can to it. We pushed the can into the pipe. When the water struck it we withdrew the can and discovered that the leak was at 200 feet from where we had inserted the wire. Then we entered cellars in the different buildings and found that a man had a printing press which was being operated with city water. He was not getting enough water to operate his press from a $1\frac{1}{4}$ service he had, so he got a plumber to connect the old $\frac{3}{4}$ -inch pipe that had been discontinued and thought he would obtain a sufficient amount of water to operate his press. We shut off the $\frac{3}{4}$ -inch service pipe and the leak stopped. That was how we found a troublesome leak with a tin can.

HOW OFTEN SHOULD WATER METERS BE TESTED?

H. F. BLOMQUIST:¹ A well made water meter is a very stable device and performs its function of measuring water remarkably well. There are, however, various disturbing elements which tend to change the percentage of registration. Some of these are general and others are of a local nature, but fortunately they do not change the percentage of registration to any large extent, except in rare cases.

Assuming that a meter is in a good condition mechanically, and that it registers within the 2 percent allowable limits when set in service, the question to be answered is: How long will it continue to register within these limits, and what causes a meter to change in percentage of registration?

Among the causes for changes in the percentage of registration may be classed the following:

1. Deposit of a film of organic or mineral compounds on the discs or pistons and on the inside of the measuring chamber, which reduces the volume of the measuring unit and causes over-registration.
2. Wear on disc balls on disc type meters so as to permit vertical play of the discs, or wear on pistons in displacement type meters, which causes under-registration.
3. Wear on disc or piston chambers, permitting irregular movements of discs or pistons, and causes increased volume of the measuring unit.
4. Too tightly packed stuffing boxes, which causes excessive friction and retards registration under small flows.

¹ Superintendent, Water Works, Cedar Rapids, Ia.

The length of time required by the various disturbing elements to change materially the percentage of registration depends largely on the character of the water and whether or not it carries silt or other suspended material. Some ground water contains compounds which precipitate as the water is subjected to different pressures and are deposited on the working parts of meters, while filtered surface waters do not generally cause this trouble. A water meter may, therefore, work satisfactorily without change in registration for a long time where the water does not materially affect it. In such cases testing for accuracy of registration is not required as often as where meters are more affected by compounds and suspended matter in the water.

Records of water meter registration tests over long periods indicate that a well constructed meter in good mechanical condition does not change materially in percentage of registration over periods as long as fifteen or twenty years, unless the water causes corrosion or leaves deposits on the meter parts. A $\frac{5}{8}$ -inch meter which had been in continuous service in a residence in our city for 19 years without any attention, was recently removed for test and was found to register 99 percent on full stream and about 95 percent on a $\frac{1}{16}$ -inch stream. Many others have been found to register within the allowable limits for periods of ten to fifteen years. Such records, however, are not to be taken as indicating the performance of all meters.

About a year ago our Water Department completed, a six year test of eight $\frac{5}{8}$ -inch meters for endurance and accuracy of registration. Six of these were set at the same time and the other two at later dates. All were regular stock meters made by different manufacturers and were placed in a boiler feed water make up line so that the same water passed through all of them. During the test no repairs or replacements of parts were made, and the meters were tested once each year and all parts examined for wear and other defects. Approximately 911,000 cubic feet, or 6,800,000 gallons of water passed through four of the original six meters which continued to register until the end of the test period. Two of the meters stopped registering on account of worn out pinions in the gear trains.

The errors in registration found by yearly tests varied between rather narrow limits and reasonably accurate registration was maintained until the end of the test run except on $\frac{1}{16}$ -inch streams, although the meters had passed as much water as would be used in an average family residence in seventy-five or one hundred years.

Meter No. 1 gradually increased in registration during the first three years up to 103 percent on both large and small streams, then

decreased to 100 percent for full and $\frac{1}{16}$ -inch streams at the end of five years, when the meter stopped registering on account of gear train trouble.

Meter No. 2 registered very accurately throughout the six-year test except on $\frac{1}{16}$ -inch stream, which varied from 103 down to 92 percent. On a $\frac{5}{8}$ -inch opening it registered from 98 to 100 percent throughout the six years.

Meter No. 3 registered from 100 to 102 percent on $\frac{5}{8}$ inch streams, and from 97 to 102 percent on $\frac{1}{16}$ -inch streams during the six years.

Meter No. 4 registered from 97 to 99 percent on $\frac{5}{8}$ -inch streams, and from 97 to 100 percent on a $\frac{1}{16}$ -inch stream for the first four years, then decreased to 87 percent on a small stream.

Meter No. 5 registered from 98 to 100 percent on $\frac{5}{8}$ -inch streams during the first four years, and 100 percent on $\frac{1}{16}$ -inch streams until the end of three years, then decreased in registration to 93 percent under small streams until it stopped registering on account of gear train trouble after three and one-half years, when 589,580 cubic feet had been registered.

Meter No. 6 registered from 98 to 97 percent on $\frac{5}{8}$ -inch streams throughout the test, but on $\frac{1}{16}$ -inch streams it decreased from 99 to 85 percent during the six years.

Meter No. 7, which was set a year and one-half later than the first six, maintained a very uniform registration under both $\frac{5}{8}$ - and $\frac{1}{16}$ -inch streams of from 98 to 100 percent during the four and one-half years of test, with a total registration of 740,060 cubic feet, or more than five and one-half million gallons.

Meter No. 8 registered uniformly from 98 to 100 percent on $\frac{5}{8}$ -inch streams, and from 97 to 100 percent on $\frac{1}{16}$ -inch streams throughout the test of three and one-half years, during which time 589,577 cubic feet, or 4,421,000 gallons of water was registered.

The water used was filtered river water and was not corrosive nor did it leave deposits on meter parts.

The results obtained in this test would indicate that standard disc water meters will register correctly and not require any attention over long periods. This is not true, however, when a meter is subject to small intermittent flows and corrosive action of water, but the mention of this experiment is made in connection with the subject because it should be of some value in studying the problem of meter maintenance and length of intervals between testing.

An analysis of tests of several hundred water meters which were

removed from service on account of premises being vacant, or other causes, such as leaking stuffing boxes, indicates that a water meter will not change very materially in percentage of registration for about ten years. Our experience indicates that with our softened river water our meters will increase in registration from 1 to 2 percent the first year then maintain a fairly regular percentage of registration for the next five or six years with a gradual decrease in registration on small flows. We find this to be true both in large and small meters. We, therefore, specify 98 percent registration on the meters which we buy, and set all repaired meters to register from 97 to 99 percent. Since it is more important to maintain accurate registration in the larger meters, it is only good business that large meters should be tested more often and maintained more carefully than smaller ones.

The speaker does not wish to specify the length of intervals between meter testings because of the many factors involved in meter performance. It may be stated, however, that in our city we aim to check all small meters at least once in seven years and 2-inch meters or larger are tested and examined once in two years. We also feel that it is just as important to maintain water meters in good mechanical condition as it is to test them at intervals. The degree of accuracy in meter registration is largely the result of good or bad meter repair work and special care should be exercised in repairs or changes in the measuring unit. If wear develops in disc balls it should be taken up by gaskets and the disc ground into the chamber to insure freedom of motion.

In determining the most practical intervals between meter testing, account should be made of the effect of the particular water on meters, the experience with meters in the water works involved, and the degree of accuracy in registration that is desired.

CHAIRMAN PORZELIUS: In testing the larger meters it is the practice at my plant to set up a quota from years of observation indicative of what time that meter will break down. We have allowed a factor of safety so that we can get a larger meter out of service before it really breaks down, or before it under-registers, because the larger meters are the ones that get into the large amounts of money and we want those to be as nearly correct at all times as is possible.

We have established different quotas for 2-, 3-, up to 6-inch meters and when the general registration on that meter comes up to that

point we either take it out, or test it in the field, as is the case with the large meters, because it costs so much money to bring them in. We find that we can test them cheaper and as effectively out in the field.

We have also done practically the same thing on the smaller meters, because with the varying house service some little house will use only a very small amount of water in the course of a year, whereas another using the same size meter will use a large amount of water. You cannot set up any precedent for taking it out within a certain number of years, unless you do add the conditions of growth which fortunately we are not bothered with.

MR. GRINNELL: The average water works has several different kinds of meters. Are you taking any steps to reduce the cost of repair by standardizing on a few kinds of meters in the various sizes?

MR. BLOMQUIST: We have the same problem, of course, as other cities which use a large number of meters. Our meters are bought partly on price and partly on the estimated service expected for the price asked. We have not been able to confine our purchases to any one meter, but since we have very accurate performance and maintenance cost records of all meters over the past ten years, we are able to compare fairly accurately the values to us of the different makes of meters. A repair card showing the initial and final test and what was done to each meter brought to the shop is filed for permanent record. From this we have found that there is not a great deal of difference between the performances of several kinds of meters in our city. I should not say that this is true in all water works because we have observed that some meters which perform well for us do not work as well in some cities which have highly mineralized ground water.

Since we have many thousand meters divided among half a dozen makes, it is not a serious problem to keep repair parts for all of them. Our repair shop has equipment and carries parts for making complete repairs to all makes of meters which we have, and it is fortunate that meter purchases have been confined to less than a half dozen makes, and we still have enough competition when purchases are made.

One thing which we have found very helpful in meter maintenance which I wish to pass on to you, is the use of rubber bushings in the

stuffing box bearing on meters which originally do not have such bushings. A large percentage of stuffing box leaks are caused by side motion of the spindle in the packing due to the hole in case being worn oblong. To remedy this condition the holes are reamed out large enough for hard rubber bushings, which are then pressed in. Bushings can be obtained at a low cost in large quantities from manufacturers of hard rubber goods.

MR. HOOLEY: The author has brought up one matter which I think will have to receive serious consideration on the part of water works men and that is the small demand for water taken for mechanical refrigerators. I find in our district they are putting in air conditioning apparatus which takes even less.

I found recently that one of the salesmen for these mechanical refrigerators was selling them and telling the people that the water would not be registered in their meters. They said they took it in in such a low rate that it would not be registered at all and they would get their water free. Unfortunately it works out that way in some cases. But where the owner of an apartment house puts in a half a dozen refrigerators we get a very substantial increase in revenue. These refrigerators require from 8 to 12 gallons per hour, 200 to 300 gallons per day.

CHAIRMAN PORZELIUS: That is a bad proposition that has been brought out by the speaker, because when those gas refrigerators first came out I became perturbed that our meters would not record it. I went to the manager of the gas company and said that I wanted a list of every one of those things that he sold, where it is made and in what house it was. He asked me what I wanted that for and I told him that I was going to put a meter on there that would catch the flow of water and he said that he did not like to do that, but because we had had cordial relationships before he gave it to me.

In some cases you might get a list like that from the gas company and in other cases you might not, but the water company should have that information available, because there are types of meters that will not record the amount of water used by those refrigerators. With the meters that we use at the present time that is the only way we can proceed.

MR. PATTON: I understand there is a contrivance they call the "gulfer." You attach this to the water meter and it will not let the small flow go through until there is sufficient water accumulated to let a little jet pass.

MR. GEAR: I have had the same trouble with those refrigerators, but I sent a couple of men out to put a small meter in of a different make and none of them would do the job. So I sent them out for a gallon measure and I told them to go and measure how much that water would run for a couple of hours. I told them to bring it home to me and not to tell the people what they were doing at all, just bring it home to me and we would measure it.

I put a rate of three dollars a year on them and they can get all they want for that three dollars and a year. They were told that they would not use any water at all, but they get the bill for three dollars a year. They are kicking about it but they are paying it.

CHAIRMAN PORZELIUS: You mean over the ordinary registration? Three dollars a year over that?

MR. GEAR: We are not metered at all.

CHAIRMAN PORZELIUS: I think that is a cheap rate, three dollars a year.

MR. GEAR: We have so much water and it is so cheap that we cannot meter it.

RELIEF FROM DOWNWARD TREND IN WATER REVENUES

BY E. E. BANKSON¹

As Chairman of the Finance Committee, Finance and Accounting Division, of your Association, I have been designated to open the discussion, regarding relief from the recent shrinkage in revenues, under the plan that those of actual valuable experience may relate their results, for the benefit of the water works profession. If there be any present who look for a magic formula whereby you can both "keep your cake and also eat it," I should hasten to warn you of my failure, in youth, to invent perpetual motion.

One Association member, of sound judgment, has offered the suggestion that a discussion of this subject is now ill-advised; with business revival well on its way. Another member has well stated that such relief is to be found in relief from the general depression.

The original assignment of this topic contemplated only gross earnings, or volume of water sales, but the subject is here taken to include both the *gross* and the *net*; in line with statement in last annual report of a large holding company to the effect that "the decrease in earnings was very largely off-set by the decrease in operating expenses." Accordingly, we divide our subject matter into two main groups, as follows, (1) means of increasing volume of sales, and (2) decrease in costs.

The existence of a decrease in water sales has been established through some sixty well scattered replies to questionnaire submitted; with certain holding companies, representing well over 100 scattered properties, submitting data on representative companies and representative groups. A summary from these replies will be found attached, wherein the decrease is indicated as largely industrial or commercial. The average decrease for industrial use, from 1929 to 1931 inclusive, is found, for those 37 segregated, at 13.2 percent; an average decrease in gross of 3.6 is indicated for only 25 plants, against a 4.8 per cent average increase in gross for 25 other plants; the ma-

¹ Of The J. N. Chester Engineers, Pittsburgh, Pa.

jority of plants, however, still showing some increase in gross of 1930 over 1929.

The writer is not greatly impressed with various plans of inducing customers to take additional water service for which they have no need, but rather my interest is centered in possible charges for existing unbilled service; by new service created through initiation of economies in certain industries; in the attraction of new industry; and in such laudable efforts as the encouragement of gardening and home beautification.

Possible increase in volume of sales may be divided into certain groupings, for convenience of discussion, as follows:

Group (a). Charges for service rendered but not now billed, such as:

- (1) Under-registration of meters from lack of maintenance; and this feature applies to large meters even to a greater proportion than to individual domestic meters.
- (2) Under-registration of meters from over sizing; which applies to large meters more than to the small.
- (3) Flat rate fixtures not recorded or billed; by interim changes in plumbing and the laxity or inefficiency of inspectors, or for other comparable reasons.
- (4) Rated or metered customers not billed as the result of certain administrative policies in vogue.
- (5) Where certain unmetered customers are rated too low; as compared to prevailing charges for other service.
- (6) Service rendered at metered rates below equity or below cost.

Losses from the first and second of the foregoing items may exist to astounding proportions and we are fortunate in having presented at the forenoon session, before the Finance and Accounting Division, two formal papers regarding effect upon water works finances, by proper meter maintenance and meter sizes. We need here only refer you to the development of those papers and to remark that our own experience includes several examples of underregistration by large meters on industrial users to the extent of 30 and 40 percent; sometimes resulting in back-billing to the extent of many thousands of dollars. It includes also most gratifying results from adoption of thorough meter maintenance policy.

Regarding unrecorded fixtures on rated service, we need not remind a body of water works men that to obtain a maximum of revenue from rated service requires a more or less constant inspection of

customers' fixtures and equipment, almost, if not wholly, equal to the effort required for meter reading of metered service. If those operators facing reduced revenues under rated domestic service have been negligent in this respect, even the by-product of employment for the unemployed would be worthy of accelerated effort; wherein the added revenue would off-set the immediate extra costs. On the contrary, however, a negligence in this respect may carry more or less merit in times of financial distress, when the burden of certain householders becomes more than they can carry.

With respect to the fourth item, of free service by administrative policy, we are familiar with certain municipal plants where private fire protection service is rendered without charge and the writer has only recently been engaged on a rate case where a private water company had been rendering both public and private fire protection service without charge. There are isolated cases, for both private and municipal plants, where certain service is rendered free of charge; in violation of equity (to pay customers), and as discrimination under modern standards of rate making. These practices can be corrected at the opportune time and, if volume of sales is now in demand, these items of discrimination, and abuse of equity, may be eliminated as the first line of attack.

Even today, there are certain types of large rated users not paying in proportion to the amount of service rendered, and meterization is the only method by which justice can be done; to the result of a most welcome increase in water revenues. Latest support of the foregoing is from quite recent experience, and such customers will be found in most any flat rate system.

If names were permissible, we could name a City serving industry, by meter measure, at a rate below that of equity and a second City serving industry at a meter rate below the point of operating cost. Such cases offer opportunity for added revenue through increase of industrial rates.

Group (b). The reclaiming of industrial water service heretofore lost through electrification of power machinery, or by other progressive changes of industrial processing, is of moment here.

Is it possible that the water works profession has stood peacefully by while the management of electric properties has gradually supplanted certain industrial water service, by electrification; through the process of high pressure salesmanship? Water service for purposes of steam power has constituted a considerable portion of water

works volume and the electrification of power machinery has been slowly but surely depleting that source of water revenue.

For untold instances electrification undoubtedly provides proper economies, but, to the knowledge of the writer, there are many other cases where electrification was adopted purely for reasons of convenience and personal inclinations; at the sacrifice of economies, even under conditions of high priced coal.

As an existing specific case, I direct your attention towards a water pumping station which was electrified during the war, because of high priced coal and high labor rates, with the steam plant held as reserve or standby equipment. Subsequent commodity prices create the condition that with coal at \$3.35 per ton, the operation of the steam plant would create a saving of \$2,500 per year, as against electric power, and that, to-day, with coal at \$2.00 per ton there results a saving of \$4,500 per year below the existing electric rates. Related to the foregoing, we observe a by-product, of extreme importance, in the form of labor, or jobs, for three additional firemen; the work of trucking the coal to the pumping plant; in addition to the mining of coal beyond that representing the slight decrease in coal for the central power station.

There are certain instances of industrial power, comparable to the foregoing case of power for water pumping, where a particular unit of the industry could avail itself of much needed economies through the operation of its standby steam plant, at present prices of coal, resulting again in the laudable by-product of jobs for additional coal tenders, truckers, miners and related activities all down the line; including the increased demand on water service. Much of the management for scattered industries is not "efficiency minded" in all directions, and if the water works profession is in need of sales volume, and is willing to compete in high pressure salesmanship for such available business, it could provide free advice of an engineering or efficiency nature to develop these local instances of possible economies in industry; to the self interest of increase in water sales.

I do not advise that superintendents become efficiency specialists but that they take on the added duties of general sales manager. The electric utilities have spent large sums of money for development purposes and their management boasts that they have found business "by going after it," to the end that water service has suffered a shrinkage to a certain degree. Aggressive electric management reflects a sales lassitude in water administration.

Water works management may, therefore, offer a free technical promotion service, not only of the nature as described above but also in coöperation with the Chambers of Commerce, in attracting new industries to the separate locations; especially if decentralization of industry is to be a solution for our industrial recovery and progress. Smaller communities would share in this leveling process in proportion to their natural environment and the combined personal efforts of the community, resulting in a gradual transfer from the present large industrial centers to points more nearly approaching the area of ultimate consumption and providing permanent advantages in labor supply. For example, we have recently experienced what might be called an industrial diffusion of the silk industry; the new processing of coal by washing methods requires large quantities of water and many new sources of water revenues may be available through intensified personal investigation and education, as also from your joint efforts with the Chamber of Commerce, depending upon specific local conditions, providing you are willing to follow the example of electric management and "go out after it."

Furthermore, it may be the prerogative of water management to challenge the freedom and wisdom of electric management in its urge for *central power load*, and we could recount a specific case where threat of reprisal called an immediate halt in this selling campaign for electrification. If water management would join hands with the coal industry in selling efficient B.T.U.'s, instead of coal, more water would be sold for steam.

Group (c). Not many years ago, at Jefferson City, Mo., a large service to the railroad was lost, by an increase in rates, and later partially regained by a proper decrease in rates.

In a recent case at bar, much industrial service has been lost by an undue increase in rates and is now invited back by a proper decrease in rates. The City of Pittsburgh has long maintained a rate for the low block which is not attractive to large industries. A lower rate might attract certain industrial service, if the City felt inclined to offer such an attraction. Accordingly, a downward revision of industrial rates might be advisable where remunerative volume would result in a proper increase of *net earnings*.

Group (d). As an example towards home beautification, the West Palm Beach Water Company, serving the Palm Beaches, Florida, offers the services of an expert gardener in the promotion of garden contests, and I believe the meeting would be interested to have some

TABLE 1
Water works statistics—Data for year 1931 as compared to 1929

QUESTION	AVERAGES (BY GROUPS)				NOMINAL	
	Group A*	Group B*	Group C*	Group D*	Maximum	Minimum
Number Reporting (Complete or Partial)	16	21	9	15		
1. Ownership—Municipal						
Private	4	12	3	12		
2. Number of Customers (average)	12	9	6	3		
3. Gross Income (Billings):	3,895	7,640	13,085	62,662		
Percent Increases, over 1929	7.9	3.84	2	5.17	-15	
Percent Decreases, under 1929	1.0	6.1	4.26	4.91	+17	
Divided as follows:						
a. Percent Domestic	**	+1.56	+6.7	+4.06	+8	-1.6
b. Percent Commercial	+7.0	-1.03	-2.16	+11.23	+19	-3.7
c. Percent Industrial	-10.4	-15.5	-17.3	-11.53	+8	-41
d. Percent Private Fire Protection	+17.1	+5.04		+7.7	+24	-6
e. Percent Public Fire Protection	+2.8	+7.36	+2.69	+13.3	+13	-7
f. Percent Miscellaneous	+3.17	-3.73	-1.64	-6.27	+69	-54
4. Percent of Total Operating Expense	-3.07	-1.37	-3.9	-0.65	+20	-21
5. Percent of Net Revenues (On Total Billings)	+1.4	+0.011	+2.8	+3.75	+25	-51
6. Percent of Delinquent Water Charges At Dec. 31st	+15.2	+61.9	-18.4	+50.4	+252	-77
7. Percent Total Exonerated for the Year			-55.16	+157.5	+600	-74
8. Percent Services Metered	88	89.37	98.9	60.5	100	2
9. Percent of Leakage and Unaccounted for Water	21.5	23.2	18.5	22.29	38	9.5
10. Percent of Time elapsed since last (or regular) Program for Overhauling all Meters						

From 12 years to Continuous

	48.6	40.6	46.3	28.2	60	2
11. Percent of Meters in System requiring repairs.....	2.5	4.2	2.08	7.3	28	0.011
12. Percent of meters in System replaced by new.....						
13. Period of time practiced between Regular Overhauling of meters.....						
From 15 years to continuous or without any program; con- tinuous and 3 to 5 years being most numerous						
14. Meter Readings per Man-Day.....	129	185	151	198	600	80
15. Percent of Operating Expense Represented in Salaries and Wages.....	50.5	49.2	61.9	62.0	87	14
16. Percent of Gross Revenues Represented in Salaries and Wages.....	14.43	20.9	21.4	22.1	45	7.5
17. Average Cost per Customer Represented in Salaries and Wages.....	\$4.76	\$5.16	\$5.01	\$9.33	\$12.60	\$2.52
18. Annual Maintenance Cost for:						
a. Street Mains per Mile of Pipe.....	36.59	24.46	61.32	59.22	113.85	1.58
b. Service lines to curb per service.....	0.51	0.454	0.477	0.61	1.80	0.011
c. Customers meters each or meters and boxes per unit.....	0.474	0.393	0.509	0.65	1.13	0.08
d. Fire Hydrants (each).....	3.51	2.23	3.82	4.51	7.31	0.02

* Group A—2 M. to 5 M. Customers.

Group B—5 M. to 10 M. Customers.

Group C—10 M. to 20 M. Customers.

Group D—Over 20 M. Customers.

** Only one reported, at +32 percent.

Note. Certain of the foregoing questions were asked in the interest of possible economy relationships, but, since the number of replies does not establish a trend, we attempt no conclusions.

comments from Mr. Reynolds, if he would care to respond during discussion.

In passing from the question of possible increase in water sales to a proper decrease in water costs, we have no thought that water service is found guilty of extravagance and inefficiency, or that any sweeping changes are needed, but by means of questionnaire we have intended to examine certain features for purpose of conversation. A summarized result of this inquiry is given in table 1 wherein certain standards of efficiency might be visualized.

For instance, we might conclude, for plants of normal size and conditions, with pumping and purification, that salaries and wages should average 50 percent of operating costs; or \$5.00 per customer; or 20 percent of gross income. Or, again, from a more reliable survey, we might find average adequate maintenance costs for distribution system at \$30.00 to \$60.00 per mile of pipe, 50 cents per service line, 50 cents per small meter to \$5.00 per large meter, and \$3.00 to \$5.00 per fire hydrant. All of these figures will vary with the size of plant, as with the physical, human and accounting differences. However, sound reason for proper differences should be available.

A low maintenance cost together with a high loss by leakage would suggest need for more maintenance work on distribution system, or a continued low cost on meter maintenance might result in an excessive loss of meter revenue. An unusually high payroll, in the face of a cry for reduced taxes, might well cause us to pause for a moment, while we consider only some phases of the subject affecting us.

If there be merit in the broad movement for a decrease in all kinds of taxes, it would then appear to follow that merit would also dictate economies and efficiencies in other walks of life. On occasion, I have observed a reluctance, or an indifference, towards reduction in operating expenses of water service, but, to my mind, it is fallacious and futile to strive for reduction in taxes without a corresponding inclination for proper economies in other departments of public service.

No attempt is here made to discuss economies and efficiencies for the production department of water service, since it would seem that the very inclination of pumping station and purification operators is towards economical results. It is rather the administrative attitude which may be worthy of our inspection. It may appear that the management of municipally operated plants is the worst offender,

in this connection; since we there find the most flagrant disregard of economies available through universal metering, with resultant increase in taxes that are worthy of our earnest consideration. In a recent issue of *Colliers* we find the statement that "a leaky faucet can do as much as a crooked politician to keep your taxes high," and also that "more than one hundred million gallons are wasted in the City of New York every day through leaky fixtures." That many cities are not thus negligent may be inferred from recent studies by others. An average 77 percent delivery of pumpage through customers meters is reported by 104 cities.²

The fact of an increase in taxes to more than eight times that of thirty years ago, while the population has increased to less than double, during that same period, would appear a sufficient warning signal that we should heed. The April 16 issue of the *Magazine of Wall Street* is authority for the statement that "The working man must carry on his back the non-producer," and in our recognition for the need of profit for the basic, or original, producer there should also be found our recognition for the need of economies and efficiencies in all walks of life; instead of passing the buck completely to a reduction of taxes.

The April issue of *Public Service Magazine* bears heavily upon the plea for reduction in taxes. A new member of the House of Representatives has recently stated "Economy in government is the paramount issue of the time. It must be reckoned with. State and National governments have been running wild and as a result taxation has reached the stage of confiscation." The editor of *Public Service Magazine* is authority for the statement that "There are more than 500,000 tax spending bodies in the United States. . . . A half million tax spending bodies can spend a lot of tax revenue. It should be kept in mind that these tax spending bodies are naturally imbued with the idea that their business is to spend, not to save," and he further states that "There is a prevalent belief that the day of the tax raider is done for."

We can, at least, make the categorical statement that disorder will be found in those cities where costly water service is being rendered on a flat rate basis. Most of us have long been convinced that economy dictates a full meterization of water service, where water is pumped and purified; while the writer has also assisted in meteriza-

² *Journal*, January, 1932, page 145.

tion of a gravity plant, which removed the necessity for costly extensions to plant capacity.

When we cite an experience of a 50 percent reduction in pumpage upon meterization, and consider the corresponding saving in capacity required of pumping works, purification works, supply mains, storage, and feeder mains, it begins to sound like an ultimate reduction in taxes or water rates; through savings in plant costs.

The saving in water capacity, however, is only a part of the saving available, as we rapidly approach the practice of sewage treatment for a majority of cities. Here again, full meterage of water service will permit corresponding curtailment of capacity in sewage treatment facilities as well as a lower requirement of operating costs.

If taxes are too high, we here find, in flat rates, one of the contributing causes; maintained either at the demand of voters or by design of public management. At least, a brief among water works men, for flat rate service under such conditions, is unknown to the writer.

A by-product of the foregoing is even of more importance today, than the stated savings in costs. A metering program for all cities now guilty of this extravagance would provide not only much permanent employment for meter reading and billing together with meter maintenance, but it would provide much more immediate employment for changes in house plumbing; installation of customers' meters; development of meter accounting systems; and the buzzing of meter manufacturing plants, together with related industry all down the line.

Many large cities are now struggling with the problem of unemployment, while opportunity is at hand for useful and needed employment, with savings in water works capacities, savings in capacity of sewage treatment facilities, savings in operating costs for sewage treatment, substantial relief to unemployment, and economy in taxes.

A possible variation in method of reply to questions 15 and 16 appears since the average figures for a certain group under holding company management appear at less than 35 percent for #15 and less than 15 per cent for #16.

The response indicated for Question #14 may be of interest in connection with the practice at Flint, Mich., of remuneration for meter readings at the rate of \$3.00 per 100³ and obtaining an average

³ Journal, January, 1932, page 153.

result of 200 per day for basement settings. Possibly two to three times this number could be expected for curb meter settings as indicated by maximum figure appearing for Question # 14, together with even higher numbers related to the writer.

Composite figures, for something over 200 private plants, earning forty million dollars per year, operated under holding company management, show the peak of revenues at the year 1930, and further indicate gross receipts of 1931 only 2 percent under 1930, together with operating expenses down 2.5 percent and a resultant net of only 1.7 percent below 1930; the same being in excess of that for 1929. This is a very different picture from that presented by general business.

BUDGETARY CONTROL OF EXPENSES

By E. C. SCHWIER¹

Close control of expenditures is an important function of good management at any time, but this importance is more keenly appreciated today in this period of depression. The Budget Control System no doubt is the best method for keeping these expenditures in hand.

The Indianapolis Water Company has operated on the Budget System for three years and while our system is not elaborate we feel we have accomplished the desired result. A brief outline of our system is as follows:

Each year heads of departments are requested to prepare requisitions covering capital additions and maintenance items of expenses. Each department is assigned a series of numbers and requisitions are numbered consecutively. Five copies of each requisition are made. These are printed on forms in various colors. The originator keeps one copy. The remaining four copies are then sent to the Engineering Department.

The Chief Engineer and his assistants investigate the nature and scope of the proposed capital additions and prepare an estimate of cost. Maintenance requirements are studied on the basis of present and future needs and also in relation to expenditures that have been made in previous years to determine whether the present requisitions are in line with previous expenditures for the same classification. After these studies have been made, the Chief Engineer recommends that the project or expenditures be authorized, deferred or cancelled. Requisitions with the Chief Engineer's recommendations are then sent to the General Manager with a report on each, together with a tabulation of all requisitions divided into two groups, one showing capital, and the other maintenance. This tabulation is known as the first tentative Budget.

Since it is necessary to obtain the Manager's approval and to avoid loss of his time, it is important that all available information be

¹ Auditor, Indianapolis Water Company Indianapolis, Ind.

attached to the requisitions for his guidance. Considerable responsibility rests on the Manager's approval or disapproval of any requisition as his recommendation is passed on to the Vice-President for final approval.

After the Manager has reviewed the first tentative Budget in detail, he approves or disapproves each requisition contained in the Budget and states whether the work is to be done by contract, and if so, who will negotiate the contract, or whether the work is to be done by Company employees. Requisitions are then returned to the Engineering Department for the preparation of a final capital and maintenance expenditure Budget. Heads of departments are then notified by the Chief Engineer regarding those requisitions which have been deferred or cancelled.

Approved requisitions are sent to the Auditor to assign account numbers to which the items covered in the requisitions are applicable. Requisitions are then returned to the Chief Engineer who assigns a work order and job number. One copy of the approved requisition together with work order goes to the department authorized to do the work, one copy to the originator of the requisition, one copy is retained in the Engineering Department, and one copy of approved requisition without work order is sent to the Accounting and Purchasing Department.

The Accounting Department's copy of the approved requisition is then referred to the Cost Clerk to be placed in proper sequence in the ledger for keeping records of work orders as work progresses. The work order number is the control number, designating to which job materials and labor are applicable. This number follows through the entire progress of the work.

This completes the first step in Budgetary Control of capital and maintenance expenditures. There are other steps which enter into the scheme. For instance, in preparing a budget there are five important points to take into consideration:

- (1) Purpose of a Budget
- (2) Organization of a Budget
- (3) Forecasting and Planning the Budget
- (4) Accounting
- (5) Results Obtained

Everyone is familiar with the purpose of a Budget so no time will be spent in explaining this feature.

ORGANIZATION OF A BUDGET

There are several ways in which to organize work for Budgetary Control: (1), Through a Budget Officer whose entire time is spent preparing and carrying on the Budget; (2), Through a Committee within the organization that prepares and supervises the Budget; (3), Through Departmental Heads preparing requirements for their immediate needs.

We prefer the third plan in that Department Heads are required to prepare requisitions covering the improvements and repairs in their individual departments. We feel that the man directly in charge of a department should be in the best position to estimate the needs of that department and considerable benefit is gained in giving Heads of Departments an opportunity to set their own goal and then strive to reach that goal. Quite often their direct interest is the difference between success or failure of a well-planned budget, as, after all, coöperation is most important for the success of any project which is undertaken.

FORECASTING AND PLANNING A BUDGET

In preparing a budget for capital expenditures in public utilities it is necessary that long-term budgeting be adopted as a public utility can not look only to its present-day needs but must forecast requirements over a period of from five to ten years in the future. We prepare a forecast of capital expenditures for major items for a period of ten years. The responsibility of this forecast rests with the Chief Engineer who is in the best position to make a study of this kind. A five to ten year forecast must be based upon a knowledge of conditions surrounding the business, both from the standpoint of past experience and what in his opinion will be necessary for future development.

After a definite forecast of capital expenditures for a period of ten years has been adopted, this forecast becomes the medium by which year to year requirements are planned. It is not probable that all items that have been forecast for a definite year can be carried out, as, when the time comes for planning the present year's needs we often find that the project that has been forecast for the ensuing year may not be needed for several years due to either changing economic conditions or to the lack of normal growth in the locality served. On the other hand, it is sometimes necessary to advance projects several years to meet changing conditions. However, with the ten

years' forecast we constantly have before us ultimate needs which lend themselves readily to a well-planned budget for current requirements.

During times of depression when securities can not be disposed of at a reasonable figure and it is an advantage to keep capital expenditures at a minimum, you can with a ten-year forecast plan a budget on those items which are absolutely necessary for the operation of the plant at such times. It is, however, not advisable to carry over from year to year deferred capital or deferred maintenance. Therefore, in planning a budget it is most important that it be so planned that the least amount of deferred capital expenditures and deferred maintenance cost be accumulated.

ACCOUNTING

After the budget has been approved and adopted it is important that we try to keep within the amounts established. However, in a public utility this rule can not be too hard and fast, because we must give adequate service at all times and emergencies, which will occur and which are impossible to forecast, must be given attention. It is therefore advisable to include in the budget an item for capital contingencies, and also for maintenance contingencies.

To keep a budget within the amounts established we must have a good accounting system. Costs must be accurately recorded and should be kept in as much detail as possible. Our practice is to keep separate costs on each job, both for capital and maintenance and we are therefore in a position to tell at all times just how much is being spent and how close the job is running to the estimate. Close supervision on each charge as to classification is necessary, as quite often an incorrect classification will cause one job to exceed the budget allowance to the advantage of another and vice versa. Each month a report is made to heads of departments advising them of the amount and per cent of the estimate which has been spent. In this way heads of departments are constantly informed as to the status of work orders for which they are responsible.

RESULTS OF A BUDGET CONTROL SYSTEM

Results obtained from a budget control system are exceedingly valuable; for instance, the detail cost of individual jobs permits a careful study of the frequency with which certain jobs must be done and permits one to ascertain the cause of these frequencies; the crea-

tion of schedules of jobs which do not occur every year, but are of such a nature as to permit a portion to be done each year, such as painting. Some items need paint each year, some every two years and so on. Rather than load one year, it is advisable to schedule this class of work so that equal portions fall in each year. This scheduling permits better control over the painting organization. The scheme also holds true with other groups of work.

The budget system also enables the manager or superintendent in charge of the property to be at all times advised of the status of work in progress. Without the budget system, where heads of departments are more or less permitted to carry on the work of their department as they see fit, the manager finds work is in progress of which he had no knowledge, but after it is once started must be completed. Although had he known of it in advance he may have disapproved or changed the plan.

The budget system largely eliminates so-called emergencies. For after all emergencies may be due to lack of foresight and a budget system demands foresight. Work done under an emergency usually costs more than if annual amounts had been provided for maintenance.

In addition to the above capital and maintenance budget we forecast revenues and operating expenses other than maintenance. This is prepared by the Accounting Department by studying past experiences over a period of years obtaining averages and taking into consideration present conditions and carried through each step of the income statement. Forecast of net income for the year 1931 came within 1.3 percent of the actual figures.

Budgetary Control of Expenses, although requiring much hard work, thought, foresight, research and planning more than justifies the amount of effort required in its preparation.

DISCUSSION

W. C. MABEE:² In opening the discussion of Mr. Schwier's paper there are several matters which have not been presented by him regarding which I desire to make a few comments.

In an organization, such as the Indianapolis Water Company, operating departmentally, there may at first be some apprehension on

² Chief Engineer, Indianapolis Water Company, Indianapolis, Ind.

the part of the operators to the introduction of new methods into the conduct of departmental business. These men, who are charged with the responsibility of conducting their several departments, were inclined to wait for emergencies to occur before setting in motion machinery to accomplish what had to be done. Some work was not planned sufficiently in advance to avoid confusion and delay in getting necessary work under way and more delay in closing the account. The manager, sensing this situation decided several years ago to introduce a budgetary control of capital and maintenance expenditures.

The first year's operation under this control system was far from being a success. The department heads felt that they were in a measure being deprived of some of their liberties. However, it soon became apparent to them that a well organized plan was preferable to the old customs.

In introducing a new scheme it is often necessary to educate your employees and to do it with the least amount of friction. The apprehension that was felt soon gave way to a feeling of appreciation on the part of these same men, and they later realized that they were actually saving themselves much time by planning a budget for their present needs, the needs of the immediate future and their far distant needs.

We have endeavored to improve on our first attempts and feel that while we have made progress there is still much to be done before the budgetary control becomes perfect.

As the scheme is now operating the department heads are required once each year to present, in orderly fashion, requisitions for those projects which they may anticipate for the ensuing year, and having received the manager's approval of them they have come to realize that the scheme is intelligent, workable and of great benefit, and we find now that these same men are supporting the budgetary control system and coöperating with the manager to achieve the desired results.

In addition to the follow up system described by Mr. Schwier, the Chief Engineer prepares monthly a condensed statement in blue print form, listing all of the requisitions that were approved, showing monthly progress, and also advising the manager of the time when other projects not yet started will probably be under way. One of the principal advantages of the budgetary control of improvement

and repair work, therefore, lies in the fact that the manager is constantly advised of the status of work in progress, and as a consequence, jobs are less likely to drift aimlessly.

It may be pointed out as a further advantage that all matters entering into the budget are considered at one time, and having reached conclusions in the matters it is not necessary to be continually giving consideration to emergency work which might have been anticipated. The fact that reports are continually passing across the manager's desk saves him much time which would otherwise be spent going about the property.

It is the purpose of the manager to maintain the plant in excellent operating condition and no essential maintenance work is deferred, although there are usually a number of requisitions rejected for lack of merit.

The allowances once approved are considered maximum appropriations for each item. If the allowance for any item is found to be insufficient to complete the work contemplated another requisition is placed during the year and it is given further consideration. The allowance in no case, however, is permitted to exceed the budget amount, unless the requisition for such excess is approved. It may be noted here that these additional allowances are taken from the contingent allowance included in the original budget.

While the operation of the budgetary control of capital expenditures has thrown much additional work upon the Engineering Department there has developed the satisfaction of reviewing contemplated projects well in advance of the time that they must be put into effect. This preliminary consideration naturally ripens ones judgment in the ultimate solution of the problems to be considered in a growing community. As a matter of fact, plans for the development of plant facilities for the Indianapolis Water Company have been projected well into the future and these studies have been decidedly educational to all concerned.

IMPROVEMENT RESERVES FOR LEVELING FINANCIAL PEAKS AND VALLEYS

BY V. BERNARD SIEMS¹

This depression has taught us many lessons. We should avail ourselves of their value in making plans in the future to avoid a recurrence of past mistakes. There is no doubt that the periodic swing of the pendulum from flashy pseudo-prosperity to economic breakdown and misery is a sad reflection on our intelligence. This is a challenge to our native ability of finding remedies to prevent such convulsions in the future.

By the accumulation of reserves during normal times we are able to meet emergencies arising during a depression. We are also able to build a more stable credit basis, which it is believed is one of the outstanding needs for which provision must be made now; unless we realize and accomplish this, the depression has taught us little.

LEGISLATION

To provide for emergencies the establishment of reserves in the operation and management of public utilities is vitally necessary. The creation of reserves of a special character, as suggested, requires in the case of privately-owned utilities the approval of the regulatory bodies of the several states, and in that of municipally-owned utilities a change in the charter through legislative enactments by the several legislatures. The relationship between municipally and privately-owned utilities is rather distant as there is no direct comparison between the two costs of service. The privately-owned public utility must pay municipal, state and federal taxes. Municipally-owned utilities, as a rule, have no direct control over their own funds, as their finances are generally closely interwoven with the municipal budget. There are, however, some exceptions; particularly is this true where definite charter provisions regulate the management of the utility, which in most of such instances is operated by a board of commissioners, and is thus more or less independent of the Mayor and City Council.

¹ Siems and Woodbury Management, New York, N. Y.

MUNICIPAL CONTROL OF FUNDS

Considerable discussions have taken place among the members of the American Water Works Association at its annual conventions regarding the question of the segregation of funds, that is, of vesting the control of these funds to some extent in the managing board of the utility instead of leaving it entirely in the hands of the Mayor and City Council. It seems almost impossible to maintain the policy of the segregation of funds set up by some of our American communities which own utilities, as the new administration coming into office usually establishes policies to suit its particular purposes. The best solution would, as far as practicable, be a clean release of the operation and management of the municipally-owned utility from the direct control by the city administration.

PUBLIC AND PRIVATE OWNERSHIP COMBINED

In order to establish independent units of municipal utilities, all the funds of which remain available for efficient service (note some of the policies established by certain municipal governments in metropolitan centers of Europe), these administrations have furnished management talent for public utilities and impose certain regulations, but they do not undertake to own and manage commercial enterprises themselves. They merely become partners in private companies. This is the case in France, Germany, England and other European nations. In Germany alone there are numerous utilities operating as joint enterprises: seventy-nine water, gas and electric companies are so managed. The municipality is limited by law to a subscription of 40 percent of the capital stock. The rates are so regulated that the investment is expected to earn at least 6, but not more than 10 percent. The government receives representation on the Board of Directors in proportion to its stock holdings. These utilities, 40 percent of whose ownership is vested in the municipality and 60 percent in private interests, are considered monopolies. The administration therefore has the power to regulate and exercise a controlling influence over the company despite the fact that it does not and cannot own a majority of the stock. It is in the nature of a co-operative profit-making business. The municipality is constantly in touch with the administration of these joint enterprises; its rights are limited by law to the extent that public representatives on the Board of Directors may not hold the offices of president and vice-

president. This provision acts as a safeguard against the exercise of excessive official power. The advantages of such a plan may be summarized as shown in part in an article entitled "Les Entreprises Mixtes" appearing in the November, 1931, issue of National Municipal Review:

- (a) It entitles the public to a share of the monopoly profits;
- (b) It permits the financial and organizing initiative of individuals to come into play, which supposedly is one of the chief advantages of capitalism;
- (c) The government has no trouble regulating the capital structure, as well as earnings and surplus, because it exercises day by day control over the industry;
- (d) Business in turn is able to check-mate the danger of functionaries abusing their official powers.

It is obvious that the municipalities of Europe, by adopting such a plan of management of utilities, have advanced a step forward in reaching an equilibrium between municipally-owned utilities and privately-owned utilities. Although in general the writer is an advocate of privately-owned utilities, where initiative functions at its best, he is convinced that the European plan is the only safeguard of efficient operation, where part ownership of the capital stock is vested in the municipality. This plan alone makes it possible to establish policies which are stable, and the funds of the utilities are controlled as would be those of privately-owned enterprises.

There are instances in our country where a utility is completely owned by the municipality, but is leased to a recognized private utility organization. This also has its advantages and disadvantages. It seems to me that the European procedure is more advanced in the direction of the true American freedom of private initiative in the management of public utilities.

PRACTICES OF MUNICIPALLY-OWNED UTILITIES ON MANAGEMENT OF FUNDS

Below is a summary of the practices in regard to management of municipally-owned utilities in the several cities in which more or less control over the funds is in the hands of the governing board:

Kansas City, Missouri. A public utility board in this city operates and manages the public utility and it acts as would a Board of Directors of a private corporation, determining policies, etc. The Board does not directly provide for improvement reserves as ad-

vocated, but it is believed that by implication it has the powers to establish such reserves, as it takes care of certain improvements through current revenue.

Mount Vernon, New York. The Board of Water Supply of this city has certain powers granted by the Legislature. A large part of the accumulated surplus has in the past been spent on construction of new mains, instead of being turned into the sinking fund, as required. This has been done to avoid the issuance of new bonds for extensions. It is possible that this Board could establish improvement reserves. It is understood that there is a tendency at present to change some of the policies heretofore established, a new Commission having recently been appointed.

Pasadena, California. The funds of the Water Department are entirely segregated from the other funds of the City. This separation is governed by the City Charter.

Memphis, Tennessee. This municipally-owned water works plant is administered by a Board of Water Commissioners which has power to create reserves. They maintain their funds for renewals and replacements in cash or liquid assets, as Government Bonds or Certificates of Deposit. Memphis, it is believed, is one of the outstanding examples of municipally-owned water works governed by a Board of Water Commissioners.

There are numerous other municipal utilities so managed, but their powers are mostly restricted, and it is doubtful if many of them could establish improvement reserves.

TAXATION—PRIVATE AND MUNICIPAL OWNERSHIP

Before leaving the question of municipal ownership of utilities, it is essential to dwell on the question of taxation which a privately-owned utility must provide for and which consumers must consider in their rate base. The municipally-owned utilities are free from this ever increasing taxation, although operating statistics show that, as a rule, these utilities are not, to any great extent, responsible for these increases in taxes.

The Federal, State and Municipal Governments of the United States received from the people \$9,342,000,000 in taxes in 1928, and it is estimated that this amount increased to \$10,000,000,000 in 1929, amounting to approximately one-ninth of the national income.

For comparative purposes, in 1913 the national income was \$34,400,000,000; the total governmental taxes were \$2,194,000,000;

or 6.4 percent of the national income. In 1921 the total governmental taxes were \$8,363,000,000 and the national income \$50,000,000,000. The percentage was 16.7 of the national income. Although in 1928 the percentage of national income was less, it is estimated that those for 1930 and 1931 increased considerably. In 1928 the municipal taxes were 50 percent of the total taxes, the State and Federal taxes being 16 and 34 percent respectively.

The expenditures of the various governments in the United States—Federal, State and Municipal—averaged approximately \$78.00 per person in 1928. In 1850 the governmental expenses were less than \$5.00 per person. This shows that in 1928 the expenditures had increased 15.6 times over those of the year 1850. In considering the increase in taxation established since the World War, allowance must be made for the lower purchasing power of money.

UTILITIES FINANCING

The basis which determines the amount of securities that may be issued by a corporation is the true cost of the physical property, including organization and overhead expenses actually incurred, to which should be added a reasonable allowance for working capital. The division of the capital structure, as to bonds, preferred stock and common stock, is governed, to a large extent, by the earnings. In many jurisdictions it is the policy to limit the issuance of bonds to two-thirds of the total capital structure, and to require that the management have an equity of not less than 20 per cent.

To put the matter differently: it may be said that the remainder of the capital structure, after deducting the 20 percent equity, may be sub-divided proportionately between bonds and preferred stock, with the limitation that the amount of bonds shall not exceed two-thirds of the total capital structure. The ratio of earnings to bond interest should also be sufficiently generous to make the bonds attractive and assure their distribution at as high a price as possible.

Having provided funds for the original plan, the problem is to obtain sufficient funds for improvements to keep pace with the growth of the community in which operations are conducted.

Two schemes of financing are in general use: some companies meet their financial requirements through local banks, as short term obligations maturing in less than one year do not need the approval of most Public Service Commissions. Meantime arrangements can be made for the issuance and sale of long term bonds and/or stock to

refund these notes. If the company is earning a fair return on the value of its property and shows a satisfactory ratio of earnings to interest charges, the substitution of bonds for these notes places the local bankers in a position to dispose of many of these bonds to local investors. In cases where the public relations are on a high plane the companies are able to sell directly to their customers practically all the securities necessary to finance the improvements.

The foregoing has been set forth in order to acquaint you with the usual procedure in financing utilities, and if the above methods were applied you can appreciate the difficulty in starting an enterprise or continuing an existing utility during an economic crisis, if provisions had not been made for emergencies during normal periods of operation—and that is what the writer has attempted to illustrate in this article.

RESERVES OF UTILITIES

The question of handling reserve accounts is one requiring special study. Utilities now have at least two principal reserve accounts: a reserve for renewals and replacements, commonly called "depreciation," and a reserve for amortization of debt discount and expense. As a rule in neither case have cash or other liquid assets been set aside in special funds for these purposes. Innumerable reserves may be set up to amortize extraordinary or unusual and unexpected expenditures not provided for in operating budgets (such as storms, accidents, etc.), or to anticipate heavy expenditures properly chargeable to operations and to be incurred at some future date. The telephone companies provide for these last mentioned reserves by setting up a certain amount each month for such emergencies. The intelligent use of these special reserve accounts and others, such as improvement reserves, is very essential for any budgetary control system, since they "iron out" the peaks and enable the local and home offices to carry on operations with greater assurance of efficiency.

The renewal and replacement reserves usually offer an opportunity to set up each year, out of the earnings, a reserve to be used in part for anticipated capital expenditures, since regulatory commissions allow funding of such expenditures to the extent of only 75 percent of improvements or extensions.

EXTENSIONS—COURT OPINION

Because of the demands by potential consumers and the requirements of regulatory bodies, it will be appreciated that the setting up

of improvement reserves during normal times is absolutely essential and dictated by financial wisdom. The following is a quotation from an article appearing in *Water Works Engineering* entitled "Water Supply Contracts" by Leo T. Parker, Esq. Attorney at Law, under a sub-heading "When consumers must pay for extension": "All Courts recognize the fact that public businesses are carried on upon a large scale and therefore reasonable regulations are plainly necessary. In recognition of this fact great scope is given by the Courts to regulations."

In the case of *State vs. Public Service Commission*, 42 SW (2d) 349, the Court said "The burden of proof rested upon the petitioners (property owners) to show that the rule in question is unreasonable or unlawful. . . . We agree with the Commission that the evidence did not so show." The Commission did not permit the overtaking of the utility's resources in order to make excessive extensions. In other words, a utility is not required to make these extensions unless a fair return on the additional investment can be expected.

Considering the difficulties to finance in times of depression extensions and improvements that bring in a fair return, is it not true that the accumulation of an improvement reserve in normal times provides funds for such extensions?

IMPROVEMENT RESERVES

Because no provision has thus far been made for improvements of public utilities during business depressions, it seems that governments should give support through loans if banking institutions fail to meet the demands.

When preparing the article on "Principles of Financing Privately Owned Water Works" (*Engineering News-Record*, May 21, 1931) the writer had in mind, considering the inability of public utilities to dispose of securities to investors during an economic crisis, asking for assistance from the Federal or State Governments. Such assistance was not to be construed as a subsidy by the Federal Government, but as temporary loans through a separate corporation with the characteristics of the War Finance Corporation, which would issue bonds against these loans. The writer hesitates to advocate such help from the Federal Government to industries and public utilities, but is nevertheless of the opinion that such an emergency measure might aid in bringing about a revival of business. If the Federal Government does not render this help the several States could organize similar corporations.

Public utilities must maintain good credit at all times, as this condition is essential for economic financing. All the important institutions and the public in general are investors in their securities. They rely on a regular income from their investments.

The necessity of expansion of service, as our present experiences indicate most convincingly, demands that such reserve be accumulated now, and executives of public utilities should submit their urgent need to the regulatory bodies of the various States. These improvement reserves should be created from reasonable increases in rates, the increases to be set aside and invested over a period of years as funds for meeting the financial requirements for this purpose.

While a straight and unqualified rate increase would be the most desirable and effective move to make, the writer has an open mind on the question of amortizing the increase by creating a recompensation fund in favor of the consumer as and when net earnings exceed the established fair return in addition to a reasonable annual amount for an improvement reserve or fund; or, resort may be had to a reduction of rates later. In the meantime the increase contributed by each consumer would be shown as a surcharge on the bill rendered.

The several public service commissions would permit the companies to accumulate such improvement funds from increased rates for a period of say seven years, at the end of which period, if earnings justify it, this fund could be repaid to the consumers in bonds and cash, say 75 percent by the issuance of funded obligations, preferably first mortgage bonds.

Such authority of the regulatory commissions will perhaps have to be given by an act of the legislatures of the several states as an amendment of the regulations applying to the financial and operating statutes of public utilities.

The writer is encouraged in asking for an increase in rates to the extent of one percent for the purpose of this reserve, because 8 percent, instead of the usual 7, is more in keeping with the rate of return on the valuation. The cost of money on the average of good and poor business periods requires this return.

Assuming that such additional 1 percent rate increase would be granted, it would, taking the following as a typical example, result in an additional revenue of \$10,000 annually, which, set aside and invested as an improvement fund at 4 percent compound interest would within a period of seven years, amount to approximately \$77,000.

This should be sufficient for improvements and extensions during a depression period. Seven year periods were selected because in the past business conditions have changed in periods of approximately seven years.

Assume:

Fixed Assets (Property and Plant).....	\$1,000,000
Capital Stock—3500 shares at \$100 par	350,000
First Mortgage 6 percent Bonds—25 years	500,000
Operating Revenue	\$130,000
Operating Expense (including Taxes and Depreciation) ..	60,000
Operating Income	\$70,000

This is 7 percent on valuation of \$1,000,000.

Interest on \$500,000 First Mortgage Bonds (6 percent) ..	30,000
Balance	\$40,000
Amortization of Debt Disc. and Exp.	1,000
Balance before Federal Taxes, Common Stock and Surplus	\$39,000

Assuming now the application of an additional one percent on the valuation for the Improvement Reserve, the Operating Revenue increases to \$140,000. Setting aside the difference of \$10,000 (\$140,000—\$130,000) in a special fund invested in bonds readily salable during times of depression, we have obtained the desired relief for the efficient functioning of a public utility during a business depression.

DISCUSSION

THEODORE A. LEISEN:² It is somewhat difficult to determine what particular part of this paper to discuss as it deals with a variety of subjects rather indirectly applicable to Improvement Reserves.

As a representative of a municipally owned Utility Corporation, the speaker feels justified in making some reference to this organization and its operating and financial methods. The Metropolitan Utilities District of Omaha, Nebraska, was incorporated by virtue of authority of the State legislature, to manage and operate the water

² General Manager, Metropolitan Utilities District, Omaha, Neb.

works and gas works, and, incidentally an ice plant. It establishes its own rates; controls its own funds; is independent of all other branches of the City Government, and is operated on a purely business, and non-political basis.

Bonds were issued first for the purchase of the water works (\$7,500,000) and later for the acquisition of the gas works (\$5,000,000). The ice plant was built with funds borrowed from the water department, it being in reality an adjunct of the water works. To date, the water bonds have been reduced to \$5,535,000, and the gas bonds to \$3,380,000, and actual reserves on hand in liquid securities, municipal and government bonds and cash, amounts to \$3,520,000. In addition to paying off nearly 30 percent of the original bond issues, and the accumulation of the reserves above mentioned, a total of over \$9,000,000 has been expended on additions and improvements to the plant,—all from earnings.

Under the law creating the District, all income not required for operation and improvements, is set aside in a fund for the payment of interest and principal on bonds. Under these conditions there is available a material amount which properly may be considered as an improvement reserve, and is, as a matter of fact, being so utilized. So much for municipal ownership if properly managed, as the Metropolitan Utilities District, with the exception of being tax exempt, is on an equal basis with privately owned corporations.

It is assumed that Mr. Siems' article is a plea for the right of privately owned utility corporations to build up an improvement reserve out of their earnings without having it counted as a part of the rate of income which they are permitted to earn under the laws of the State Utility Commission to which they are subject. If this could be done under adequate safeguards it might be beneficial in providing capital for utilization in new construction work during times of depression, but two questions suggest themselves in this connection:

1. Would the average corporation be willing to authorize an increase in its capacity during a time when, because of a business depression, the demand for the use of its service was below normal and decreasing still further to an unknown extent?
2. Would there not be grave danger, as indicated by recent events, of having any such funds dissipated in ways not primarily intended, regardless of imposed restrictions?

These are questions which should be carefully weighed before commitment to the adoption of the suggested plan which, primarily,

must recognize an increase in rates sufficient to create this added reserve.

Relative to the effect on the general economic conditions of the country, if a number of public utilities were enabled to put this plan in operation, and utilize it during periods of depression, it is assumed that the total volume of construction possible under its provisions would be such a small percentage of the whole Nation's activities as to minimize its general effect, and would, at best, be a rather feeble step in the right direction.

Reference is made to dual ownership and control of utilities by municipalities and private parties in a species of co-partnership, with the municipality in the minority. In the complex and somewhat peculiar conditions which at times develop in some City governments, might not the controlling majority, with the influence its representatives could wield, tend to foster or create a situation, which to put it mildly, would prove inimical to the best interests of the community? This plan would not appeal as advantageous or desirable for this country.

The time limit set for this discussion precludes reference to other details covered by the original article.

CONSTRUCTION AND OPERATING RECORDS OF PLANT FACILITIES

BY J. E. JAGGER¹

This paper has been limited to a discussion of one plant facility—the distribution system, and certain maps and records in connection therewith as maintained by the Alabama Water Service Company.

During recent years, modernization and efficiency in businesses of every description has led to the necessity and demand for very detailed and accurate records and accounting. In the public utility field, such records are not only considered necessary for the successful operation of the property, but are required in almost every instance by public service commissions and various other regulatory boards. The numerous reasons for detailed, yet practical, records of distribution systems are self evident, but a few of the outstanding ones are worthy of mention.

From a financial standpoint, the success of any water works utility is largely dependent upon the ratio between earnings and capital investment. Since the distribution system represents a large portion of the total capital investment—approximately 60 percent in our system—records pertaining to the distribution system are of great importance, and should be one of the most valuable maintained regardless of the type of ownership, whether private, municipal or corporate. Particularly is this true inasmuch as this major portion of the capital investment is entirely underground, whereas other plant facilities such as purification and pumping equipment, storage tanks, buildings and the like are of much easier access for inspection.

Although material and labor prices may vary from time to time, detailed records of the cost of past work are most useful in preparing estimates for proposed extensions, and also in making retirements of existing property.

In the event of a break in a main, a valve or several valves must be quickly located and closed in order to check a large loss of water, and also to minimize damage to property and the interruption of service.

¹Chief Engineer, Alabama Water Service Company, Birmingham, Ala.

A complete and accurate set of maps is of untold value in making engineering studies in connection with leakage surveys, future extensions, and pumping and pressure problems. A good system map becomes an aid to the accountant in determining, for tax purposes, that portion of distribution system investment located inside and outside of corporate limit or county lines.

The Alabama Water Service Company, a subsidiary of the Federal Water Service Corporation of New York, operates water works systems in thirty-six cities and towns in the State of Alabama—the headquarters office being located in Birmingham. These communities vary in population from 700 to 24,000 and are situated in all parts of the State.

Although not elaborate, nor too greatly detailed, the system of distribution records which we have established is considered quite sufficient to serve our purposes. In order to illustrate the function of each phase of this system and to show the relationship of field and office records, I shall outline the course of a typical main extension from the time of a request for service by a prospective consumer, until the job is completed and recorded on our maps, and also will point out the value of our map records in the event this, or any mains installed under this system, should be retired at some future date.

THE EXTENSION APPLICATION

Regardless of cost, all extensions or additions to our distribution systems are made only upon authorization from the Birmingham Office. Meters and services, however, are installed whenever necessary at the discretion of the Local Managers or Field Superintendents, and are handled under blanket authorizations issued at the beginning of each year. When a prospective consumer, or consumers apply for water service, and it becomes necessary to extend our mains to serve them, the Local Manager makes up an Extension Application which is forwarded to the Birmingham Office in triplicate.

These forms are printed on 8½ by 11 inch sheets—the original on white paper, the two copies on pink and yellow. On the face of the Application appears the name of the plant; the date of application; the annual gross revenue to be derived; the annual revenue expressed as a percent of the investment; a description of the work to be done; and any pertinent remarks relative to the new consumers; and also a sketch showing the relation of the proposed work to the existing system. A grid representing city blocks is printed on the form for this

RECORD OF MAIN EXTENSIONS

DEPARTMENT OF
Alabama Water
MAPS & RECORDS
Service Company

PLANT ----- Prichard
FROM ----- October 1, 1930
To ----- October 1, 1931

DATE	EAT No.	No.	Fr.	Size	DESCRIPTION	ESTIMATED COST	DATE NY App'd.	Job No.	DATE RECD.	FLAT Laid	LOCATION L.C.L.	PERCENT O.C.L.	TOTAL COST	COST DIST. L.C.L.	UNIT O.C.L.	SPECIAL DATA	
10/25/56	PR-56	1300	2"		Prichard Lane & Ave. "D"	\$552.34	10/27/56	PR-32	PR-56	4-18-31	4-19-31	12.90	100	\$600.34	\$600.34	6.468	
FIRST ENTRY																	
SECOND ENTRY																	
THIRD ENTRY																	

Fig. 2

use. Sometimes, however, the actual street layout is such that it is impractical to use the grid, in which case a separate sketch sheet is

EXTENSION APPLICATION

ALABAMA WATER SERVICE CO. DATE _____

PLANT _____ AUTHZ. NO. _____

REVENUE _____ NORTH _____ % OF INVESTMENT _____

DESCRIPTION AND REMARKS

BY _____

APPROVED B'HAM DATE _____ PLANT SUPT. _____

APPROVED NEW YORK

_____ ENG. AUTHZ. NO. _____

_____ PRES. DATE _____

FIG. 3

attached to the Application. Some superintendents make these sketches by tracing a portion of their distribution system map. Distinction between the existing mains and proposed work is made

by use of colored pencil or ink. On the reverse side of this same form, the Local Manager makes up a detailed estimate of cost of the proposed work.

MATERIAL

ARTICLE	UNIT COST	TOTAL
1. 1000	1.00	1000.00
2. 1000	1.00	1000.00
3. 1000	1.00	1000.00
4. 1000	1.00	1000.00
5. 1000	1.00	1000.00
6. 1000	1.00	1000.00
7. 1000	1.00	1000.00
8. 1000	1.00	1000.00
9. 1000	1.00	1000.00
10. 1000	1.00	1000.00
11. 1000	1.00	1000.00
12. 1000	1.00	1000.00
13. 1000	1.00	1000.00
14. 1000	1.00	1000.00
15. 1000	1.00	1000.00
16. 1000	1.00	1000.00
17. 1000	1.00	1000.00
18. 1000	1.00	1000.00
19. 1000	1.00	1000.00
20. 1000	1.00	1000.00
21. 1000	1.00	1000.00
22. 1000	1.00	1000.00
23. 1000	1.00	1000.00
24. 1000	1.00	1000.00
25. 1000	1.00	1000.00
26. 1000	1.00	1000.00
27. 1000	1.00	1000.00
28. 1000	1.00	1000.00
29. 1000	1.00	1000.00
30. 1000	1.00	1000.00
31. 1000	1.00	1000.00
32. 1000	1.00	1000.00
33. 1000	1.00	1000.00
34. 1000	1.00	1000.00
35. 1000	1.00	1000.00
36. 1000	1.00	1000.00
37. 1000	1.00	1000.00
38. 1000	1.00	1000.00
39. 1000	1.00	1000.00
40. 1000	1.00	1000.00
41. 1000	1.00	1000.00
42. 1000	1.00	1000.00
43. 1000	1.00	1000.00
44. 1000	1.00	1000.00
45. 1000	1.00	1000.00
46. 1000	1.00	1000.00
47. 1000	1.00	1000.00
48. 1000	1.00	1000.00
49. 1000	1.00	1000.00
50. 1000	1.00	1000.00
51. 1000	1.00	1000.00
52. 1000	1.00	1000.00
53. 1000	1.00	1000.00
54. 1000	1.00	1000.00
55. 1000	1.00	1000.00
56. 1000	1.00	1000.00
57. 1000	1.00	1000.00
58. 1000	1.00	1000.00
59. 1000	1.00	1000.00
60. 1000	1.00	1000.00
61. 1000	1.00	1000.00
62. 1000	1.00	1000.00
63. 1000	1.00	1000.00
64. 1000	1.00	1000.00
65. 1000	1.00	1000.00
66. 1000	1.00	1000.00
67. 1000	1.00	1000.00
68. 1000	1.00	1000.00
69. 1000	1.00	1000.00
70. 1000	1.00	1000.00
71. 1000	1.00	1000.00
72. 1000	1.00	1000.00
73. 1000	1.00	1000.00
74. 1000	1.00	1000.00
75. 1000	1.00	1000.00
76. 1000	1.00	1000.00
77. 1000	1.00	1000.00
78. 1000	1.00	1000.00
79. 1000	1.00	1000.00
80. 1000	1.00	1000.00
81. 1000	1.00	1000.00
82. 1000	1.00	1000.00
83. 1000	1.00	1000.00
84. 1000	1.00	1000.00
85. 1000	1.00	1000.00
86. 1000	1.00	1000.00
87. 1000	1.00	1000.00
88. 1000	1.00	1000.00
89. 1000	1.00	1000.00
90. 1000	1.00	1000.00
91. 1000	1.00	1000.00
92. 1000	1.00	1000.00
93. 1000	1.00	1000.00
94. 1000	1.00	1000.00
95. 1000	1.00	1000.00
96. 1000	1.00	1000.00
97. 1000	1.00	1000.00
98. 1000	1.00	1000.00
99. 1000	1.00	1000.00
100. 1000	1.00	1000.00

COST

	BY PLANT SUPT.	CHECK BY S'FIAM
ESTIMATED COST		
COST OF MATERIAL	\$	
COST OF LABOR	\$	
HAULING AND MSC.	\$	
TOTAL	\$	
ENG. AND O'HEAD	\$	
GRAND TOTAL	\$	

ACTUAL COST

COST OF MATERIAL	_____	
COST OF LABOR	_____	
HAULING AND MSC.	_____	
TOTAL	_____	
ENG. AND O'HEAD	_____	
GRAND TOTAL	_____	
PER CENT OF EST. COST TO ACTUAL COST		BY _____

FIG. 4. REVERSE SIDE OF "EXTENSION APPLICATION" SHEET

Upon receipt in the Birmingham office, these Applications are first submitted to the Engineering Department for a thorough check and approval with respect to the cost estimate and construction details.

The Application is then submitted to the Operating Department for their approval of the expenditure. Whether approved or not, every Application is recorded in our "Record of Main Extensions," and proper notations made in all columns designated as "first entry." In the illustration, a typical application for a 2-inch main extension at Prichard, Alabama, has been recorded. If, and when the Application is approved in full, the two copies are sent to the Accounting Department—one being retained there in a job file, and the other forwarded to the Local Manager—the receipt of which is his authority to proceed with the work. The original of the Application is filed by the Engineering Department.

THE COMPLETION REPORT

As soon as the work has been completed and placed in service, the Local Manager makes a report to the Birmingham Office using a form designated as the Completed Extension Report. These forms are also made out in triplicate. They, also, are printed on eight and one half by eleven sheets—the original on green paper, the first copy on blue, and the second copy on yellow. Only the original and first copy of this report are forwarded to Birmingham—the other copy being retained in the Field Office. The original is filed in the Engineering Department, and the blue copy forwarded to the Accounting Department—this being their authority to close the job. For brevity, and by reason of the color of the original, these reports have become known in our Engineering Department as "Green Sheets." On these reports appear detailed field measurements, actual lengths of pipe laid, and various dates such as when work was started, completed, and placed in service. As in the case of the Extension Application, a separate sketch sheet is attached to the report in the event it is impractical to make use of the grid printed on the form on account of an irregular street layout. If for any special reason, the actual construction quantities or cost vary appreciably from the estimate, the Field Superintendent makes an explanation on this report.

THE RECORD OF MAIN EXTENSIONS

From the information received on the Completed Extension Report, further entries are made in the "Record of Main Extensions"—notations being made in all columns designated in the illustration as "second entry." This information gives full detail not only on

construction quantities mentioned, but also location of the main with respect to corporate limit or county lines, and the location of the end of the main with respect to property lines of intersecting streets.

COMPLETION EXTENSION REPORT ALABAMA WATER SERVICE COMPANY

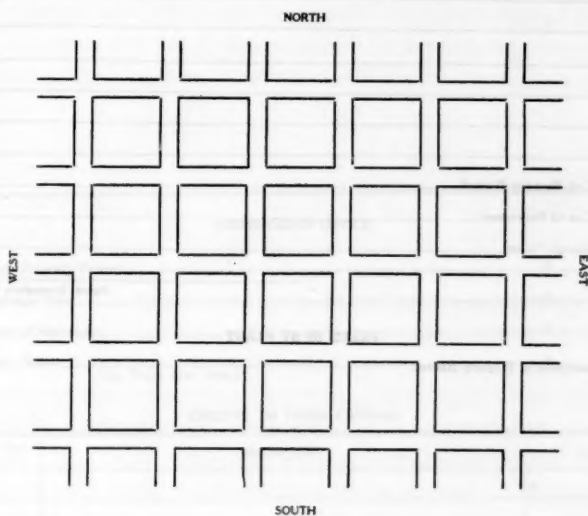
Date _____

Plant _____ Authz. No. _____

DATE FIELD WORK STARTED _____ DATE FIELD WORK COMPLETED _____ DATE WORK WAS PLACED IN SERVICE _____

_____, 19____, 19____

(Make diagram showing size and length of pipe in each street, distance from property line to all VALVES, HYDRANTS AND DEAD ENDS. Diagram must be complete, measurements correct and oriented to points of compass.)



DESCRIPTION AND REMARKS.

By _____

Plant Supt.

Received and filed in Birmingham office.

Entered on Dist. Map.

By _____

By _____

Date _____

Date _____

FIG. 5

We have so designed this form that the quantities of pipe laid inside city limits (I. C. L.) or outside city limits (O. C. L.) are recorded separately, and also expressed as percentages of the entire job

exception of meters and services, all the capital additions at each plant for one tax year are recorded on one sheet in this Record of Main Extensions.

REMARKS (if any)

BIRMINGHAM OFFICE

Actual Cost Property Retired	\$
Actual Salvage Value	\$
Actual Cost of Retirement	\$
Net Salvage Value	\$

(Dr. Trojan Engr. Corp.)

CREDITS TO FIXED CAPITAL

N. Y. No.	Acct. No.	DESCRIPTION	Cost
			\$
		Total	\$

DEBIT OR CREDIT TO RETIREMENT RESERVE

			\$
		Total	\$

Prepared by _____ Audited by _____ Approved by _____

FIG. 7. REVERSE SIDE OF "RETIREMENT FORM" SHEET

Although all of the record forms described thus far have been designed primarily for distribution system use, we use them for any capital investment to be made at every plant. Thus, if it is desired

to install a pump, or any other equipment, an Application for the expenditure is made just as though it were a main extension. Likewise a regular Completion Report is made, and entries noted in the Record of Main Extensions for all types of construction work.

The cost data are furnished to the Engineering Department by the Accounting Department in the form of a Cost Analysis from which final entries are made in the remaining columns designated as "third entry" in the Record of Main Extensions. By using the percentages worked out relative to the lengths of pipe laid inside or outside corporate limit lines, we accordingly assign costs to either area.

Thus we have a complete history of every addition to our distribution systems, no matter how large or small the job may be, and all supporting data are kept on file in the Engineering Department.

MAPS OF DISTRIBUTION SYSTEMS

Every main extension is plotted in the Map Book within a day or two following the receipt in Birmingham of the Completion Report. The sheets used in the Map Book are 24 by 36 inches, and are plotted to a scale of 200 feet to the inch. No attempt is made with such a scale to show accurate location of the main in the street with respect to parallel property lines, nor the exact location of valves and fire hydrants. These maps are drawn quite accurately but are diagrammatic only—the dead ends, however, are plotted as accurately as the scale will permit. The necessary data for such plotting are taken from the Completed Extension Report.

The illustration shows a small portion of a typical Map Book sheet of our Prichard system. The figures near each hydrant denote the number assigned to that hydrant. We have found it rather useful in sending out men on inspection and oiling work, and also in painting, to number all hydrants on our maps, and inspect or paint them in numerical order so that none will be omitted. Numbers are not marked or stencilled on the hydrants in all cases, but some Local Managers have considered it worth while to do so.

At each intersection, and also near gate valves not located at intersections, the number in a circle and prefixed by the letter "P" denotes the page number in a Valve Book where may be found very accurate and detailed location of all valves in that intersection or locality. In this way the Map Book sheets serve as an index to the Valve Book. However, the names of the intersecting streets appear at the top of each page in the Valve Book so that it is not a difficult

matter to locate any intersection by turning through the pages in the book. In some cases, Valve Book page numbers have been provided and noted on the map in several places for future valves—our purpose in this being to keep Valve Book pages grouped together for certain portions of the city.

The sheets in the Map Book are blue line prints, and as each Completion Report is received, the new extension is plotted directly into the book in red drawing ink. Once a year, immediately following the close of the tax year, each sheet in the Map Book is inspected for "red additions." The tracings of all sheets having such additions plotted during the past year are removed from the files for revision. New blue line prints are then made and inserted in the book, and the sheets being replaced are filed for possible future reference. Blue line prints of all Map Book sheets are kept at the respective field offices, and the Local Managers keep them plotted up to date in a manner similar to that described. New prints are sent to them annually after revision.

As each extension is plotted in red ink during the year, and also on tracing during revision, the job number under which the work was done is noted on the map so that these extensions may be later identified for retirement or any other purpose.

On that portion of the Prichard map illustrated, there are faint lines drawn across the streets at dead ends and a date indicated. These denoted the location of dead ends at that plant on that date and were plotted following a thorough field check of that particular system. Similar faint lines without dates are drawn to indicate the extent of main laid under a particular job number.

Map Book sheets are so drawn that adjacent sheets may be matched to each other along match lines which are drawn on each sheet. Along these match lines are noted the drawing numbers of adjacent sheets. Some Local Managers carefully trim their prints along these lines and mount them to serve as a large scale composite map on the walls of their offices.

A book of photostatic copies of all sheets in the Map Book is kept in the author's office for desk use. This small book is kept up to date in the same manner as the large one, and new sheets are inserted annually. The sheets in this desk copy are reduced to one half size—12 by 18 inches—and the resulting scale of 400 feet to the inch is sufficiently accurate for the purpose of checking Extension Applications as they are received.

THE VALVE BOOK

As each valve, or group of valves, is installed, the Local Manager or his foreman takes several measurements to be used in making up sheets for the Valve Book. Valve locations are made by the method of "swing ties," and measurements are taken to surface objects of either permanent or semi permanent nature such as the near faces of telephone or power poles; operating nuts of hydrants; corners of brick buildings, manhole cover centers; railroad spikes driven into roots of large trees; concrete curbs; railway and street car rails. Valves are also tied in with respect to each other. These notes are forwarded to the Engineering Department with the Completion Report, and are transferred to $8\frac{1}{2}$ by $5\frac{1}{2}$ tracing sheets, from which blue prints are made and punched for a standard loose leaf note book of the size mentioned.

These sketches are not drawn to scale. Of course, only two swing ties are necessary for the location of any one valve, but usually several ties to each valve are made to preclude the possibility of not being able to locate a valve in case a pole or other reference object is removed unknown to the Local Manager. On the typical Valve Book sheet illustrated, no location data are given for the valve on the fire hydrant leader—the reason being that in this particular system, flanged hydrants were installed, and the valves were bolted directly onto the foot piece, making the center of all hydrant valves about fifteen inches from the center of hydrants. Since all mains are laid as straight as possible, no location data are deemed necessary for mains along the blocks between intersections. If it is desired to excavate to the main in the middle of the block, the location may be determined with sufficient accuracy by sighting between valves at both ends of the block. Where possible, however, various Superintendents have established some standard distance from north and west property lines for laying mains. Several Valve Books are kept at each plant—one in the office for emergency use, and one in each service truck.

COMPOSITE MAPS

It is always desirable, when possible, to have a map of an entire system on one sheet, and plotted to a very small scale. Such maps are made for our larger systems. The sizes and scales of these composite maps of course can not be standardized, but depend entirely upon the size of the city, and the scope of the system. The scales

for such maps are usually 400, 500, or 600 feet to the inch. As in the case of the Map Book sheets, these maps, although drawn accurately to scale, are diagrammatic only with respect to the system, and show mains, valves, and fire hydrants. On all of our map work the sizes of mains are denoted by figures rather than by using varying widths of line which is confusing if there are many different sizes of main in the system. Whether of cast iron or galvanized iron, all mains 2 inches and smaller in diameter are shown as dotted lines. On all composite small scale maps, the areas covered by map book sheets are outlined so that a composite map further serves as an index to Map Book Sheets. However, all Local Managers are so familiar with their distribution systems that such procedure is not entirely necessary, but is sometimes quite useful in the Birmingham Office.

RETIREMENTS

All retirements are handled in exactly the same manner as main extensions in so far as the Engineering Department is concerned. Whenever a retirement is to be made in connection with construction of new work, the Local Manager makes note of this fact on his Extension Application, and makes a statement of what he expects to retire, the estimate cost of retirement, and the anticipated salvage value.

The upper half of the Retirement Form illustrated is then filled out by the Engineering Department and mailed to the plant in triplicate for the information from the field requested on the lower portion of the sheet. All copies are returned to the Accounting Department in Birmingham for completion. The Engineering Department supplies the information requested on that portion of the sheet headed "Birmingham Office." One copy of the completed Retirement Form is then filed by the Engineering Department, and any necessary changes are made in our Map Book or Valve Book. Completion Reports are required for all "separate" retirements, that is, retirements which are not the result of new construction. Completion Reports already mentioned for new construction carry all information regarding retirements when made in such cases. The value of our maps in making retirements is realized when original cost data is desired—as such data can be readily found by referring to the map for any section of main to be retired, and noting the job number under which that section of main was originally installed on which the actual cost per foot is required.

With the forms and maps which have been described, the maintenance of our distribution system records is a comparatively easy matter, and does not require a large amount of time in our Engineering Department. All phases of the record system are not yet in complete operation at every plant, but are being incorporated as rapidly as possible. However, all office records mentioned are being maintained in connection with work being done and retirements being made so that it only remains to get all the map system in operation, and we anticipate having the system in complete operation within the next ten or twelve months.

PENSION FOR WATER WORKS EMPLOYEES

By J. S. DUNWOODY¹

In approaching the subject of employees retirement or old age pension, I desire to have it considered as an economic rather than a social problem. Pension, as the term appeals to the writer, is a certain consideration honorably given for meritorious and continuous service, a payment for services rendered, and not a hand-out to keep body and soul together. Let us therefore consider this subject as strictly a business proposition, and in no sense a form of charity.

Every organization, municipal or private, which remains in business over a considerable period of time, will ultimately have a pension cost. It may be true that this cost does not appear on the balance sheet, but hidden in the payroll it is a part of the cost of production, or is definitely attached to the overhead. Sooner or later some of the employees will have grown too old properly to discharge their duties with the maximum efficiency, and yet are retained on the payroll, either at their regular work or some lighter job. Supervising employees are loath to discharge a faithful old man or woman who has no means of support, and the consequence is that the employer, oft-times without realizing it, continues to pay salaries for active service which such employees are no longer able to perform satisfactorily.

It is evident that every employer must sooner or later assume a cost of this character. It may be hidden as above referred to, or it may be classified as a gratuity for long and faithful service, but it is nevertheless a cost which he must assume whether he chooses or not.

When facts are clearly set forth, and these facts constitute an ever-increasing problem, is it not the part of good business to solve the problem to the best interests of all concerned? Might it not be well to put as much stress on the study of pensions from the standpoint of what they contribute to the economic as well as the social well-being of both the employer and the employee, as it is to continue with some haphazard and unknown distribution of funds for those who have grown old in service? If the subject is approached in this way

¹ General Superintendent, Water Department, Erie, Pa.

I believe it will greatly clarify the all absorbing and disturbing question of costs.

Long and continuous service by workmen implies constantly increasing experience and efficiency, and the resultant reduction in labor turnover is a marked saving to the employer. The assurance of a pension, to be granted upon retirement, conditioned upon unbroken service of a period of twenty years or more, is no doubt an inducement to continuous employment,

How many of our workmen will be in a position of complete independence for themselves and their families when they reach the point of inefficiency in their present occupation? This spectre, which haunts so many of our wage earners, is not without justification, as they are unable to set aside sufficient funds to provide for their retirement. Every self respecting workman dreads the thought of being a burden to his relatives or friends. Has it ever occurred to you that freedom from mental worries is an essential to maximum working efficiency?

The adoption of a retirement pension system removes the necessity for worry over the future, and cannot help but bring about an increase in personal working efficiency.

The superannuated employee who is held on the payroll in some hidden or disguised manner, either by the company itself or some considerate department head, can be released, with general satisfaction to all concerned, under a properly devised pension plan, and his place filled by the younger man who will carry efficiency and vigor into the job. This advancement to the younger employee can be credited as an asset by the employer, because such a stimulus to personal development will show a consequent improvement in morale.

When an accounting department makes an operating set-up, the items of depreciation and obsolescence in machinery are given prominent places. When costs are computed these items have their part to play, and are never omitted in the properly regulated business. When the human organization is assembled to operate and control this machinery, is the same thought given to depreciation and obsolescence? It is just as much present in the manpower of your organization as it is in the machinery, and should be given more consideration.

In suggesting a set-up for retirement pension for the water works employee, I do not see any necessity or advantage in going into the many ramifications or layouts which have been operative with vary-

ing degrees of success during the past years. I will confine myself to three types of plan, the Self-Funded, Trusteed and Underwritten. I will also confine myself to but two methods of operation of a plan, non-contributory and contributory.

NON-CONTRIBUTORY OPERATION

Let us consider first the non-contributory scheme of operation. By this method the employer pays the total cost. This plan exists largely in private companies, and usually these companies have had a pension in operation for some time. It represents a very generous attitude of the employer toward his employee, but of necessity must be protected with many strings, as for example "The company reserves the right to modify or discontinue the entire system at their own discretion." It is subject to the many whims of business such as mergers, changes of administration, bankruptcies, etc.

CONTRIBUTORY PLAN

The contributory plan calls for payments to the fund to be made jointly by employer and employee, and this is the method of operation I would like to recommend for your serious consideration. Anything worth having is worth striving for. If a retirement pension is worth looking forward to by the employee, he should have a part in building it up. On the other hand, if an employee can be retired in comfort at the point of inefficiency, the employer should have done his full share toward the bringing about of such a retirement. Both parties benefit and both parties contribute.

Such a plan would of necessity involve some contractual features, usually guaranteeing to the employee the return of the money he has placed in the fund upon leaving the employe of the company or municipality, or upon dissolution of the pension system. It should include provision for the return of deposited funds on account of death, and many other protective details so important to the average employee.

The Contributory plan should be established as a protection against old age dependency, and under no circumstance as a savings fund. The strict enforcement of such a provision makes a much larger pension possible.

SELF-FUNDED PLAN

The Self-Funded type of plan is that plan which is self-administered and self-funded. The Self plan may be classified into three groups with respect to degree of funding.

First, the plan under which no liability is recognized until a payment is made to a pensioned employee. Such payments are then entered as current disbursements, and no direct item appears on the balance sheet.

Second, the plan for which an actuarial evaluation of the pension liability has been made and has been entered as one of the items on the liability side of the balance sheet.

Third, the plan for which the liability has been entered on the balance sheet, and for which in addition a corresponding amount has been segregated and set up as a Pension Reserve in the assets.

I have enumerated the three groups of this plan for funding, but many other variations can, and usually are, made part of this type of set up.

The services of an experienced actuary is exceedingly important to provide the basis of beginning. The same services are a necessity from time to time during the operation of this plan to cope with changing condition, and to prevent the unbalancing of the fund. Supervision of fund investment requires very careful consideration. The possibilities of special assessments always lurk in the background, and again a change in administration, a merger, or a sale might completely upset the plan.

TRUSTEE PLAN

An improvement on the Self-Funded plan is the "Trustee Plan." Under this method such funds are removed from corporate control and placed in the hands of trustees, either individuals or companies, chartered for that purpose. This procedure is a safeguard in that the funds are removed from such hazards as changes in administration, mergers and the like, and are protected under trust agreement.

THE "UNDERWRITTEN" PLAN

As a marked improvement over the above described types of retirement plan, may we consider the "Underwritten" plan, where all the features are guaranteed by an insurance company. The Insurance Company assumes the actuarial investment and administrative functions, and coöperates with the employer in carrying out all of the features of the adopted plan. It assures both the employer and employee of a definite cost for benefits to be derived, thereby eliminating any chance for assessment or the lowering of benefits when due.

Under this arrangement the employer gives the insurance company

the necessary census data covering the employees. The machinery for the adopted plan, together with cost of same, is then furnished by the insuring company and no further obligation, beyond the payment of premiums, rests on either the employer or employee. Moreover, the employees are assured that funds in the hands of the insurance company cannot be in any way attached. The plan may be amended but only with respect to distribution of benefits. Similarly, the plan may be terminated at any time, but all benefits provided to that date are thereupon vested in the respective employees.

A recent study by a leading life insurance company of a group of selected plans in United States and Canada establishes the following facts:

TYPES OF PLANS	CONTRIBUTORY	NON- CONTRIBUTORY
Underwritten.....	30	1
Trusteed.....	3	3
Self-Funded.....	12	4

Of the 53 plans studied, 31 were underwritten by an insurance carrier, 16 were self maintained, and 6 were in the hands of a trustee. Forty-five were contributory and 8 non-contributory.

NECESSITY OF ACTUARIAL ADVISE

Municipal pension systems in the United States date back as far as 1860. Since that time it is estimated that some 600 municipalities throughout the country have established Pension Funds or Retirement Systems for their employees. Of course, in some instances, enabling legislation had to be obtained, as the existing laws did not permit of such expenditures.

For the most part, these benefits cover policeman, firemen or teachers. The plans that have been designed to include other municipal employees are relatively few. However, I am glad to report that increasing recognition of the need for Retirement Systems covering municipal employees other than policemen or firemen, and with special reference to the employees of municipal water works, is evident on all sides.

Prior to 1915 the percentages of salary or the amounts contributed by the employees or a municipal division to any pension fund were generally fixed arbitrarily without regard to the cost of the pensions

to be paid. Already in some instances disbursements have exceeded the revenues and, of course, a number of these loosely constructed retirement systems are quite definitely headed for actuarial and financial insolvency. In the same way frequently the amounts of the pensions to be paid and the terms under which they were to be paid were fixed without regard for the requirements of efficient service, and sometimes even without regard to the individual equities of the employees.

In due time as actuaries and students of the subject pointed out the inevitable deficits to be experienced, and as the terms of the plans themselves irked many of the employees, there arose considerable dissatisfaction and commissions in a number of cities were asked to investigate the whole matter.

The result of these investigations brought forth, in the form of reports and general discussions, the idea that retirement systems should be so financed that it would be possible to enjoy actuarial solvency of the fund at all times. If a complete breakdown of many funds involving decreased benefits or increased assessments was to be avoided, municipalities must heed the actuaries' advice. With this thought in mind, a number of municipal retirement systems were revised on an actuarially sound basis, and the benefits fixed with a clear knowledge of the cost involved.

One major result of all this investigation was that most of the non-contributory systems were changed to the contributory basis, and where no pension funds existed, new plans were set up on a sound basis.

EXAMPLES

New York was the first City to begin this pension research—an investigation having begun in 1913. The New York City Commission gathered much data on mortality, disability, withdrawal rates, and studied carefully appropriate amounts of pension, retirement ages and other features to make up an efficient and effective retirement plan.

In 1917 the New York City Teacher's Retirement System was established by law, and so far as I can learn this was the first system in the United States to provide for the systematic accumulation of reserves. Several years later a second law was enacted establishing the New York City Employees Retirement System which covers all municipal employees except policemen, firemen and teachers. These

systems were of course set up on an actuarially sound basis with the advice of men specially trained in pension mathematics.

In 1921 we find Illinois and Wisconsin enacted special laws establishing Municipal Retirement Systems on an actuarial basis in Chicago and Milwaukee. The Chicago plan includes all municipal employees except policemen, firemen and teachers. This latter group had their own plan as in New York City.

Just a word about the usual benefits and contributions of these plans and then I will pass on to a definite suggestion for retiring employees of the water works group.

Some of the contributory plans revised on a sound basis provide for a uniform rate of contribution from the employees, others provide for rates graduated according to age at entry. For example, in Boston employees and the City each contribute 4 percent of salary. In Chicago the employee contributes $4\frac{1}{2}$ to $4\frac{3}{4}$ and the City 9 percent or more.

The amount of the annuity or pension to be paid to the employee depends entirely on the amount of the reserves accumulated to his credit at the time of retirement.

In the second type of system where the contributions are graded according to entrance age, we find the employee depositing between 3 and 7 percent in order to accumulate at a certain age the reserve sufficient to pay a retirement allowance based on a certain proportion of his salary.

The retirement age is usually set at 60 or 65. In case of resignation, dismissal or death before retirement, the contributions of the employee in most of these systems are refunded to him or his dependents generally with interest, but we find records of some plans operating successfully without return of interest.

THE PLAN AT ERIE, PA.

After considerable investigation by the Commissioners of Water Works at Erie, Pennsylvania into the history of pension funds, not only of municipalities but those operating in industrial organizations, certain definite principles were evolved which it was felt should govern the setting up of a retirement plan for water works employees.

The conclusions reached were.

1. That the plan should be contributory, that is, employees should share in the cost.
2. That the employee should have a contractual relationship and

a definite guarantee that he would always be sure to get his money back if he left the service or that nothing would interrupt or discontinue his pension once commenced.

3. That the amount of the pension should be proportionate to the salary and also proportionate to the employee's length of service with the department.

4. That the plan should be fully underwritten in a reliable insurance company.

Some of the details of our plan for the water works employees in the City of Erie may be of interest.

1. The retirement age is normally sixty-five. This age of retirement, however, is thoroughly flexible and, with the consent of the Commissioners, retirement may take place before or after sixty-five as the interests of the service required.

Our investigation of municipal retirement plans indicated that for our kind of work Age 65 was appropriate and, of course, from the standpoint of accurate mathematical treatment, it was necessary to have a definite age of retirement in order that reserves could be set up on an actuarial basis.

2. All water works employees were included in the plan when it was initially offered on June 1, 1930. New employees may join at any anniversary of the plan after six months' service with the Department.

3. The amount of the retirement income for each year of membership in the plan varies according to salary. For the sake of simplicity of operation and better understanding by the employees, all employees were divided into salary classifications, and the retirement benefit and contributions were made proportionate to the mean salary in each salary group. The schedule on page 1945 will give the complete picture of our benefits and contributions.

This schedule is built up on what is known as the 1 percent plan, and the contributions by the employees represents 46 percent of the carrying charge. The balance is paid by the Water Commissioners. A plan calling for greater Retirement Income could be set up if conditions demanded, but for our needs we felt the 1 percent plan sufficient.

There is no maximum Retirement Income, nor is there a minimum. In each case, because the Water Works Commissioners provide for past service, there is ample income even for old employees so that a minimum pension could be avoided.

ANNUAL RATE OF SALARY OR WAGES	SALARY CLASS	MONTHLY RATE OF RETIREMENT INCOME FOR EACH COMPLETED YEAR AS CONTRIBUTOR IN SALARY CLASS	EMPLOYEE'S MONTHLY CONTRIBUTION	CASH SURRENDER VALUE ON WITHDRAWAL OR DEATH BEFORE RETIREMENT
\$1,350 and less	A	\$1.00	\$2.00	100 percent of all employ- ee's contri- butions
1,351-\$1,650	B	1.25	2.50	
1,651- 1,950	C	1.50	3.00	
1,951- 2,250	D	1.75	3.50	
2,251- 2,550	E	2.00	4.00	
2,551- 2,850	F	2.25	4.50	
2,851- 3,150	G	2.50	5.00	
3,151- 3,450	H	2.75	5.50	
3,451- 3,750	I	3.00	6.00	
3,751- 4,050	J	3.25	6.50	
4,051- 4,350	K	3.50	7.00	
4,351- 4,650	L	3.75	7.50	
4,651- 4,950	M	4.00	8.00	
4,951- 5,250	N	4.25	8.50	
5,251- 5,550	O	4.50	9.00	
5,551- 5,850	P	4.75	9.50	
5,851 and over	Q	5.00	10.00	

4. The Retirement Income for past service is equal to the monthly rate of Retirement Income shown in the above schedule multiplied by the number of years of continuous service the employee had completed prior to the adoption of the plan.

This income, of course, is based on the salary classification of the employee at the time the plan went into effect.

5. If the employee withdraws from the plan at any time prior to the normal retirement date, he has three options as follows:

- (1) He may have all of his contributions in cash.
- (2) He may continue his contributions to the insurance company and receive a monthly income payable for life from the Normal Retirement Date, as provided by the total amount of his contributions.
- (3) He may leave his contributions with the insurance company and receive a monthly income payable for life from the Normal Retirement Date, as provided by his own contributions up to date of withdrawal.

6. In the event of death before retirement, all of the employee's contributions are returned to the beneficiary.

In the event of death after retirement, any excess in the amount of the contributions of the employee, over the amount of Retirement

Income already received, is paid immediately in one lump sum to the beneficiary.

7. A member of the Plan may at any time prior to five years preceding the Normal Retirement Date elect to receive a reduced annuity commencing on the Normal Retirement Date, the amount varying with the age of the wife, with the understanding that it will be continued to his wife if she survive him. In the event of the death of either, before Retirement Income commences, this option shall not apply.

This plan is designed with the primary thought in mind that the Retirement Income was the definite goal to be reached, and that it was not a savings plan. To have provided interest on the employee's contributions in case of withdrawal or death would have required contributions from the employees of approximately one-third more, or the Commissioners would have had to increase their contributions to the plan accordingly.

The experience of many organizations inaugurating plans of this sort indicates employees join such plans gladly and willingly if they can be assured of a cash surrender value at any time equal to 100 percent of their total contributions.

We felt, therefore, that a cash surrender value of 100 percent of the employee's total contributions was sufficiently attractive to justify the plan on the present basis and would make it unnecessary to increase the employees contributions to account for the interest factor.

The Commissioners of Water Works in the City of Erie hope and expect to continue this plan into the indefinite future, but they must necessarily reserve the right to change or discontinue it at any time. However, one of the strongest features of the plan is that any change or discontinuance cannot affect the benefits secured by the employee's contributions, as well as those contributions the Commissioners have made towards the employee's Retirement Income made prior to the date of such change or discontinuance.

In order to obtain this sufficient guarantee and complete security for the employee's contributions, as well as those of the Commissioners, we secured the backing of a large financial institution whose business it is to administer and guarantee benefits under Retirement or Annuity Plans and, therefore, the whole plan was given to the Metropolitan Life Insurance Company as the guarantor.

DISCUSSION

MR. WM. W. BRUSH:² Mr. Dunwoody has presented to you a subject which I believe is probably closer to our real personal interests than any other subject, especially those of us who are employed by municipalities where a pension system can be reasonably assumed to be one that will be permanent.

Mr. Dunwoody has set forth the situation where systems have been started which were not sound actuarially, and those systems are simply mirages to many because they indicate that you will have an income to depend upon in your old age and when you get to it the income mirage disappears because of the unsoundness of the plan and usually you have then reached an age which precludes later substantial capital accumulation. I believe I can most successfully add to the helpfulness of this paper by presenting to you as briefly as I may what has happened in our pension system in New York City. The New York City pension system for the general employee, eliminating, as Mr. Dunwoody has stated, the firemen, the teachers, the police, and as I recall also the street cleaning department, is a most generous system to the employee. It is based upon an equal contribution from the city and the employee with, however, the City taking over for us older employees the contribution which we would have made, prior to the introduction of the system in 1920 had the system been in effect at the date of our entrance into the service. The result is that for an old employee like myself, who was in the service some twenty-six years prior to 1920, the City has assumed that entire liability. The City also assumes the cost of the administration of the funds. The funds that are contributed are definitely segregated, by our comptroller. The comptroller's annual report sets forth the amount that is in the pension fund. Generally it is believed by the employees that the amount set aside is greater than is necessary. With that view I am not inclined to agree, although I believe the fund is sufficient to meet its obligations.

We contribute on the basis of retirement at the age of seventy for other than the skilled and unskilled labor class, and for them the age is 69 for the skilled and 68 for the unskilled labor. If you are in the general classification 1/70 of your average annual salary for five years prior to retirement is allowed for each year of service. On this basis,

² Chief Engineer, Department of Water Supply, Gas and Electricity, New York, N. Y.

as I have been 37 years in the service, I would receive 37/70 of my salary if I retire at the present time.

There have been some changes made since the system was established which have increased the advantages from the viewpoint of the employee. One now has the option of joining a class that will reserve 1/60 for each year of service by paying a higher contribution. To make you eligible for the 1/60 class you have to make up the differential on an actuarial basis, between the 1/60, and on the 1/70 class. The result was that men like myself had to make a substantial contribution, some \$3,000, in order to attain the 1/60 class, but that gives me the option of retiring at 1/60 of my salary for each year of service.

We have also had the insurance feature increased. We were originally insured by the City for one-half our annual salary, so that in case of our death our dependents would receive one-half of our salary, plus the return of our entire contribution, plus 4 per cent compounded annually, or semi-annually, I am not sure which. That insurance is now for a full year's salary after you have been, if I recall correctly, ten years in the service. Also, after twenty years in the service, irrespective of whether you are in the classified service or exempted service, if you should retire from a cause other than your own volition, you are entitled to the pension; in other words, in case of a layoff you are entitled to the pension, represented by whatever may have been the service at that time.

We have always been entitled to a disability pension, but in that case, as usual, we have to be subjected to a medical examination I think once a year to determine whether disability has been removed so that you can come back in the service.

New York has no limit on the amount to be paid. No matter what your salary is, it is the percentage of your salary, and there is no maximum or minimum limit. Some of us have thought that a minimum limit might be desirable, because unfortunately from the viewpoint of efficiency of our service the age at which a man is allowed to enter the service, especially the labor class has been fixed too high. We frequently think a man should be retired and yet the retirement allowance is so small we do not try to force retirement. We have a bad feature also in that the legislature extended the time of compulsory retirement beyond seventy years by allowing a two-year extension, provided the head of the department certified it was desirable and the board of estimate authorized it and, that extension can be renewed up to eighty. The actual working out of that requirement

is that a man comes up to the compulsory retirement age, seventy, and he asks for an extension of time. Unless he is very badly handicapped by age, the extension of time is generally recommended. The man is probably rendering service worth more than the difference between his pension and the amount the City is paying him. You realize that if he retires he is usually the type that would probably have nothing to do, and he would usually die within a year or so, because if we retire them and they have no hobbies, they develop all sorts of ills and rather quickly go out of the picture. I think I have only refused two extensions within the last year or so but I believe it would be much better if we should adhere strictly to a retirement limit of seventy, and let everybody go out after that time.

There are other important provisions in our retirement system; for instance, I could retire at the age of 55; that means, I am able to retire at the present time, and it is entirely at my own option, unless I were notified it was the intention to appoint another Chief Engineer, in which event I would immediately make application. If I make application to retire it legally becomes effective thirty days thereafter. On account of the very few men who retire when they reach the retirement age, it is the general belief of the employees, although our very good actuary says to the contrary, that the retirement fund is increasing at an unexpectedly rapid rate.

The effect of the pension on the service has been, I feel, definitely beneficial. It has attracted to the service men who probably otherwise would not come into it. What is more important, I think, it has helped to retain men in the service who are competent men and who were attracted at times by outside opportunities but stayed in the service because of the future pension. We all of us know that the vast majority of us could not be able to take care of our financial future as we grow older, if we did not have somebody else to compel us to do so. If you look back over the history of your family you will undoubtedly find that the men of the family were receiving satisfactory incomes up to a certain age, and then instead of the financial background being fairly well secured it tapered off and finally reached the vanishing point before the individual died. Usually it is most important that some central agency should make it necessary that we provide for our financial future.

The pension system has had one detrimental effect. We have some good men who when they get to the retirement age, when they could retire of their own volition, take the attitude, that the City is paying

them only the difference between their pension and their salary, and they slow down in their activities, and adopt an attitude toward their work which is distinctly detrimental. I do not know how that comes about in human nature, nevertheless it is something to be reckoned with. I do not put it forth as an argument against the pension system, because I am one hundred percent for it, but I wish to point out that situation which has been very evident with some of our really good men.

I think that as an Association we should endeavor to encourage the establishment of a pension system. We are definitely as a nation working towards the old-age pension plan, and as a group in the water works field, especially for those of us who are in the municipal employ, it would be decidedly to our advantage to have a sound pension system. Whatever we can do as an Association I certainly believe we should do to encourage the establishment of these systems.

I have not told you what our options are when we retire. We have four options. Fortunately none of them permit any return to you directly of the capital value of your pension—unless you drop out of the service or die in the service, and then it is returned to your family or dependents. I believe it is very desirable that the prospective pensioner can not have the capital sum paid to him as he might then be tempted to do so and later lose such sum by unfortunate investments. We are allowed first to take the flat pension which ceases upon our death. If we die the day after we drop out, that is just too bad, except from the City's viewpoint; it is all right for the City, because the City then retains the capitalized value of our pension. Our second option, which is the one more generally taken, is where there is a reduced amount paid, and a return is made to the estate of the pensioner upon his death of whatever is left over from the capitalized value of the pension after deducting the gross amount paid as pension. The capitalized value is usually about ten or twelve times the amount of the pension. There is no interest allowed on this capitalized value. For instance, let us assume that the man's capitalized pension is \$40,000. Whatever is paid to him is deducted from the \$40,000, and whatever is left at the time of his death is turned over to his estate. After the period when the entire capital amount has been used up his pension continues without any change, but there is thereafter no payment upon the death of the pensioner. The third and fourth options are somewhat similar. The third is where you have a designated beneficiary, to whom, after your death, is paid the full amount

of pension, which is of course reduced on an actuarial basis due to this option being selected. Under the fourth option one half of the pension is paid after your death to the designated beneficiary. For instance, I could designate that Mrs. Brush after my death would receive one-half my pension until her death.

I have limited myself to telling you what New York is doing in its pension system, because I think the New York system is at least as liberal as any in the country, and a very sound one actuarially. I think I have contributed at the rate of between seven and eight percent, but I can stop the contribution after I reach the optimal retirement age of 55 years if I wish. The majority of us do then stop payment, and wish later we had continued our payments. The city continues its yearly payment even if the employee stops his payments and for those years the employee gets $1\frac{1}{2}\%$ or $1\frac{1}{4}\%$.

There is one other thing which has been added recently which is very desirable, and that is that you can borrow up to 25 percent of your contribution, and the maximum period in which you can pay off that amount is two years. You can arrange to have this loan paid off in six months if you want to, but you get the money promptly, and the six per cent interest helps the fund investment, because the general return on the investment, which is entirely in City bonds, is somewhere around four percent, and that borrowing feature has been found to be very helpful to many of our employees.

MR. A. M. BOWMAN:² The Hydro-Electric Power Commission of Ontario is an independent Corporation. We make application to the Hydro-Electric Commission for getting in on the pension scheme and they act on behalf of the municipality. The employees of Public Utilities Commissions are eligible to join, if employed in any of their utility operations besides the electric distribution, which in London, Ontario, includes parks, gas company, water works and electrical distribution. Three leading life insurance companies underwrite this contract or policy. It is based on the salary of the employee. The amount of pension received varies according to age. No employee can come in after he is sixty years old, and that is, old employees. In case the scheme is adopted no new employee can come in after thirty-five years of age. In case an employee is out of a utilities commission's service in one place, he can transfer to another

² Superintendent, Public Utilities, Elmira, Ontario, Can.

public utilities commission under the same jurisdiction and all the benefits he had built up in one section would be transferred to the other, but in case he retires entirely off the system and was not employed under any public utility commission, he could then receive all the money he paid in, at four percent interest, and included in that there is an insurance clause attached of approximately $1\frac{1}{3}$ of the annual salary of an employee. Suppose an employee was receiving \$1500 a year, he would be insured for \$2000. If the employee had been with a company or corporation for fifteen or twenty years, the scheme is only made retroactive to about eight years. Each employee contributes and the ordinary retiring age is set at sixty-five, but his limit is seventy. It is optional at other years, and the amount of the pension is greatest for employees entering early.

RECENT TRENDS IN FACTORS AFFECTING THE RATE BASE

By L. R. Howson¹

In these days of depression in which costs of all kinds are in such general decline, there has developed a demand for lowered rates for utility services, in the consideration of which the fundamental difference between public utilities and industrial properties are frequently overlooked. Among these differences may be noted the following:

1. Utility rates are predicated, in large part, upon the value of the property devoted to the public service (i.e., the rate base). Industrial earnings are based upon what the traffic will bear as regulated by the economic laws of supply and demand.

2. The rate of return allowed on regulated public utilities is lower than that required to attract capital to the financing of industrial properties, due to the monopolistic nature of the utilities and the assurance that, while highly remunerative returns will never be received, neither must confiscatory low returns be feared. Interference with this principle will adversely affect the cost of attracting capital to utilities and thus raise the rates for service.

3. With public utilities the depression in general has resulted in a lowered "rate base" and increased the cost of attracting capital, which tend to offset each other, to some extent at least.

4. Changes in rates for public utility services usually involve negotiations and hearings extending over a year or more and large expenditures in connection therewith: industrial charges can be changed frequently and at the sole instance of the owner.

One state utility commission at least has recently entered an order fixing the fair rate of return of 5 percent on the depressed rate base secured by estimating the cost of reproduction, less depreciation, at the prevailing low costs of materials and labor. Appeal to the Federal Courts on the basis of confiscation has been taken by the Company. The evidence is now before the three Federal Judges, whose decision is being awaited with considerable interest.

If the fair rate of return varies with "opportunities for investment, the money market and business conditions generally" as stated in

¹ Alvord, Burdick and Howson, Consulting Engineers, Chicago, Ill.

the Bluefield decision, it is difficult to see how the rate of return can be lowered in this period of practical inability to borrow funds even at high rates of interest.

It is quite evident that the present economic conditions have created more discussion relating to the proper methods of determining the "rate base" for utilities than has been apparent since the early part of the past decade when costs were rising even more rapidly than they have been falling in recent months. In this connection, it is interesting to observe that the important public utility cases growing out of this earlier economic adjustment were not decided by the U. S. Supreme Court until 1923 to 1926, several years after the peak of prices had passed.

In the Bluefield case,² the Supreme Court stated—"Rates which are not sufficient to yield a reasonable return on the value of the property used at the time it is being used to render the service, are unjust, unreasonable and confiscatory"—and in the Southwestern Bell Telephone case³ decided in the same week, the Court states: "It is impossible to ascertain what will amount to a fair return upon property devoted to public service without giving consideration to the cost of labor, supplies, etc. at the time the investigation is made. An honest and intelligent forecast of probable future values made upon a view of all of the relevant circumstances is essential. If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today."

The U. S. Supreme Court further indicated its position relative to the determination of the rate base for public utilities in the following language: "If the tendency or trend of prices is not definitely upward or downward and it does not appear probable that there will be a substantial change of prices, then the present value of lands, plus the present cost of constructing the plant, less depreciation, if any, is a fair measure of the value of the physical elements of the property." Thus, cost of reproduction, less accrued depreciation, is the most commonly accepted yardstick⁴ for measuring public utility values at the present time.

² Bluefield Water Works & Impr. Co. vs. West Virginia Public Service Comm. 43 Sup. Ct. Rep. 675.

³ Southwestern Bell Telephone Co. vs. Pub. Serv. Comm. of Mo. 43 Sup. Ct. Rep. 544.

⁴ Indianapolis Water Co. vs McCardle-47 Sup. Ct. Rep. 144.

In all of these cases the court recognized that value lies in the future and that the reproduction process utilized as measuring value must be based upon the prices likely to prevail during that estimated period in the future which would be required to construct the property. The court stated, "But in determining present value, consideration must be given to prices and wages prevailing at the time of the investigation, and in the light of all the circumstances there must be an honest and intelligent forecast as to the probable price and wage levels during a reasonable period in the immediate future. In every confiscation case the future as well as the present must be regarded."

The logic of the court in the above statement is apparent. A property cannot be physically constructed or reproduced in the past—neither can the rates predicated upon its present value be collected in the past. Both are future operations. This fact, combined with the present economic conditions, raises many interesting questions relative to determining the "rate base," now a subject of inquiry in so many cases.

Are utility construction costs likely to remain as at present when we are in a buyers' market, with few buyers? Will prices still further recede due to economies developed by the necessities of the depression period, or will prices rebound with the return to normal conditions? Upon careful study and analysis of prices, developments in the industries, ability to earn under present prices and similar items, depends the answer as to what constitutes a fair rate base under the meaning of the U. S. Supreme Court.

In general, it is believed a fair statement that engineers of the various State Utility Commissions are adopting "spot prices" in their reproduction estimates, thus in substance indicating a belief that the present prices will prevail for the next one to three years. Where a valuation on this basis results in rate reduction it is quite probable that some cases will be appealed to the higher courts on the confiscation issue. In that event, in view of the fact that it normally takes two or three years for an appeal to reach and be decided by the U. S. Supreme Court, that body will have available actual recorded experience rather than the forecast necessarily made at the present time.

The Court has indicated its position in this matter on both rising and falling price trends, and also with respect to the rate of return to be allowed on the rate base. In the Illinois Bell Telephone case⁵

⁵ Smith vs. Ill. Bell Tel. Co., October term 1930, U. S. Sup. Ct.

the court stated, "A rate order which is confiscatory when made may cease to be confiscatory, or one which is valid when made may become confiscatory at a later period." With respect to rate of return the same court stated² "A rate of return may be reasonable at one time and become too high or too low by changes affecting opportunities for investment, the money market and business conditions generally."

Confiscation as used herein is not limited to condemnation proceedings. It applies equally well to rates fixed by regulatory bodies. The power to regulate is not the power to destroy. Rates fixed so low as not to yield a fair return on the rate base constitute the taking of private property without compensation and without due process of law just as surely as condemnation of the property itself at a price below its fair value.

If cost of reproduction is to be the measure of fair value, its application must include all costs which would arise if the property were to be constructed today, whether or not such costs are directly reflected in the historical records of the Company. It must, therefore, include the item of overheads.

Possibly it may assist to define what is meant by "rate base" and "overheads."

By "rate base" is meant that property valuation upon which a utility is permitted to earn interest or return after having paid all expenses of operation and maintenance, and, in addition, having set aside, as a depreciation reserve, an amount sufficient to amortize the property during its anticipated life. In this discussion the term "rate base" is used interchangeably with "plant value," "value of the property," "value," and "property."

The term "overheads" is intended to define and include those costs which enter into the total cost of the physical property in place, but which cannot be satisfactorily allocated or apportioned to each specific item of the plant.

TYPES OF OVERHEAD EXPENSES

There are, in general, three types of overheads which affect the "rate base:"

1. *Construction overheads* which include liability insurance, construction superintendence, rental on construction equipment, contractor's profit, telephone and telegraph expense, etc. This type of overhead is generally included in the unit prices applied to the various items rather than being separately designated.

2. *General overheads*—Among the general overhead expenditures are those which are incurred in bringing a utility plant into being, but which do not apply directly to the physical property as do field or construction overheads above referred to. Included under general overheads are such items as engineering, management and legal expenses, contingencies and extras, interest and taxes during construction, etc.

3. *Intangible overheads*—The third type of overheads is sometimes referred to as "intangible," being those which attach to the property during its early operating stages as well as during construction and which to some extent reflect earning capacity.

Construction overheads

There is rarely much question relative to the inclusion of construction overheads in the rate base with the exception of the item of "Contractors' profit." The contention is sometimes made that the rate base should be determined on the basis of having all materials purchased and assembled into an operating plant under general contract, and that, of course, necessitates the allowance of contractors' profit on the entire cost of materials and labor. Some utility decisions have supported this viewpoint. Others have held that allowance for contractors' profit should not be applied to such items as cast iron pipe, meters, valves, hydrants, and pumps which are purchased directly by the Company without the aid of the contractor.

General overheads

The items generally included under this heading are necessarily and properly a part of its cost and therefore of the "rate base," although they are not capable of physical identification after the completion of the construction work. They cannot be covered in the rate base by the application of specific unit prices. They attach to the coördinated property, in whole or in large part, rather than to any particular unit.

Even casual thought will make it evident that legal expense incurred in connection with tracing title to real estate is as essential and as much a part of the property as the fence which designates its boundaries.

The engineering costs incurred in making surveys, plans and specifications, setting lines and grades, etc., are just as integral a part of the coördinated property as the cost of materials or of carpenters driving nails or of laborers digging ditches. The difference arises from the fact that the latter items of work and costs are specific and

can be readily allocated or apportioned to individual articles or accounts, whereas the engineering costs are not capable of such treatment.

The construction of a property cannot be financed without the loss of interest on expenditures between the time when the costs are incurred and the beginning of operations. Capital cannot be diverted from a profitable investment to a new construction project without incurring the cost included among general overheads as "interest during construction." Its existence is undisputed. Not to allow it in the rate is partial confiscation, even though it applies to the property as a whole rather than to specific items.

The status of these general overheads with respect to the rate base has been clearly stated by the New York Public Service Commission, Second District, in the following terms: "The question whether overhead expenses should be allowed in a valuation for rate making is neither moral nor legal, but merely one of fact since such expenses are actual and real."⁶

Intangible overheads

In recent years, the item commonly designated as "going value" or "going concern value" has constituted the major item of intangible overheads found in the rate base. Formerly, stress was laid upon the inclusion of "goodwill" and "franchise" values, but in recent years, the Courts, Commissions and engineers have almost invariably eliminated these items from the rate base of monopolistic utilities.

Going value may be defined as that element of value of a property which represents the difference between the physical value and the value of the property as a whole with its developed income, organization and established business. It has sometimes been more briefly defined as the "value of an established income."

Going value is more than goodwill with which it has sometimes been compared. Going value exists in every successfully operating property. Goodwill exists only in those properties whose consumers use the service in preference to other competing service to which they have equally free access. Water works are generally considered to be monopolistic utilities; however, that is not strictly the fact, for practically every water works is in direct competition with wells,

⁶ Lockport Light, Heat & Power Co. P. U. R. 1918, 675

cisterns and individual supplies, particularly from its larger industrial consumers and to that limited extent may possess "goodwill" in addition to "going value."

Going value

It is interesting to note that the recognition of going value and the development of methods for measuring it have largely taken place in the water works field. The Kansas City Water Case, the first in which the principle of going value was enunciated, contains an outline of the principle as stated by Justice Brewer in the following terms: "The fact that it is a system in operation, not only with capacity to supply the city, but actually supplying many buildings in the city, not only with the capacity to earn, but actually earning, makes it true that the fair and equitable value is something in excess of the cost of reproduction . . . such a system would be a dead structure rather than a living going business."

Growing out of that opinion, came the necessity for expressing in dollars what was there laid down as a principle. Numerous methods of measuring going value have been developed, most of which have been unable to stand the test of time and have been discarded.

One of the early methods for some years extensively used, was based upon an analysis of the deficits incurred in the early years of operation. It is generally admitted that every new enterprise must go through the development stage. This past deficit method, sometimes referred to as the Wisconsin Commission method, measured going value by an analysis of the early deficits. The larger the deficits incurred, the greater the going value. Obviously, the application of this method placed a bonus upon poorly conceived, poorly managed utilities. Application to a few outstanding examples demonstrated its weakness and it has been largely abandoned, but not until it had seriously retarded the adoption of more sound methods of measuring this important item. The U. S. Supreme Court discussed this method in the Galveston Case⁷ sometimes quoted to disprove going value, but which in reality only disproved a fallacious method of computing it in connection with a cost of reproduction estimate of the physical property.

In recent years, since the cost of reproduction has been given predominant consideration in fixing the rate base, going value has been

⁷ Galveston El. Co. vs Galveston 42 Sup. Ct. Rep. 351.

computed on the same theory. The cost of reproducing the business has been estimated by applying the same methods and principles to the reproduction of the business as are applied to the *physical plant* in estimating its cost of reproduction.

The cost of reproducing the business of a utility is measured by the costs which an investor would have to incur in transferring his funds from a channel in which it is now earning return to another involving the construction of a property and its development to a point where it, too, will earn a fair return.

For illustration, let us assume that in its present channel the money is earning 7 percent per year and that if diverted to the new channel one year will be required to build the plant and two years more required to develop a business producing 7 percent return. Obviously, in the three year period his present investment will yield him 21 percent. The new enterprise will earn nothing during the year of construction and something less than 7 percent per year in the two years of operation necessary to acquire a remunerative 7 percent business. The difference between the 21 percent net earnings in one case and the lower amount in the other (with present worth adjustments, interest credits, etc.) represents what it would cost to create the income of the new project and accordingly measures its going value on the cost of reproduction theory.

It is sometimes urged that the measurement of going value is a mysterious matter based on theory and conjecture, and accordingly the results so obtained, are not concrete. As a matter-of-fact, the computation of going value as above outlined is no more conjectural than the cost of reproduction of the physical property. The accuracy of the computation depends upon three fundamental facts:

1. The cost of reproducing the physical property as of the date of the inquiry.
2. How much time will it take to reproduce the plant; that is, period of construction.
3. How long a time will it take to recover the business.

The first two factors are identically those adopted in estimating the cost of reproducing the physical property. The third factor can usually be developed from the experience of the particular plant being valued compared with the data from other sources and ascertained within reasonable accuracy.

When these fundamental factors have been determined upon, the

measurement of going value by the cost of reproduction method is purely ordinary mathematics.

In the early years of public utility appraisal, the newly formed public utility commissions particularly were inclined either to ignore going value or cover up any direct allowance in a blanket statement as to its general inclusion. This procedure resulted in many appeals to the Courts and many statements by the Courts relative to this item as a specific element of public utility appraisal. It is now quite generally set forth as a separate allowance.

In water works cases, it is the quite general practice of commissions and Courts at the present time to allow going value in the amount of approximately 10 percent of the physical plant value. Going value is however not a uniform percentage. It varies with different utilities. All other factors being equal a business which costs more than the average to acquire, is worth more after it is acquired, just as a building constructed in a metropolitan center with \$2.00 an hour labor has a higher value when completed than one built in the country with 50¢ an hour labor.

Going value also reflects the future usefulness of the utilities service and accordingly the going value of a rapidly expanding utility business is larger than one less rapid. The going value of a utility performing a service for which there is a declining demand may be negative rather than positive as illustrated by the case of a logging railroad after the timber supply is cut and the mills moved elsewhere or of a waterworks in a mining town where the workings have been exhausted, the mines shut down and the houses largely abandoned. Such a plant is worth less than the physical cost of reproduction on account of the negative going value.

It is believed that eventually, Courts and Commissions will give greater recognition to the factors influencing the amount of going value in each individual utility.

Going value in monopolistic utilities is ordinarily somewhat less than in the semi-competitive, semi-industrial utilities which are now made subject to regulation. Going value is almost universally allowed at the present time as a separate item of public utility value.

Accrued depreciation

The matter of determining the accrued depreciation of a utility property is still one producing wide variations in testimony before

regulatory bodies. Obviously, the amount deduced for accrued depreciation directly affects the rate base.

The principal progress in the matter of determining accrued depreciation has been due to the greater emphasis being placed upon the physical condition of the property itself as contrasted with an arbitrary determination of depreciation based upon the use of sinking fund, straight line or other methods of computation, based *wholly* upon averages.

The Supreme Court has stated its position in the following language. "The testimony of competent valuation engineers who examined the property and made estimates in respect to its condition, is to be preferred to *mere* calculations based on averages and assumed probabilities." Note that in this statement, the Court uses the word "*mere*" as defining calculations. This statement combined with a statement in the prior paragraph of the same decision indicates the attitude of the Court, for in the preceding paragraph, the Court states that the witness "made an estimate of existing depreciation based on actual inspection and a consideration of the probable future life as indicated by the conditions found." This position is believed to be eminently fair and sound. Accrued depreciation is a matter of observation tempered by the known facts or history of the unit being valued and considered with respect to its probable future usefulness. It is believed that an adequate determination of accrued depreciation involves both detailed physical inspection and comparison of the conditions surrounding the particular equipment with those affecting large numbers of similar units whose life history is known, so as to throw all of the light possible upon the equipment being valued and the probability of its future usefulness in the utility of which it is a part.

Annual depreciation

It is only within the past two years that the Supreme Court has spoken authoritatively with regard to the basis for providing for annual depreciation reserve. Many of our State Utility Commissions in their standard instructions for accounting of utility properties, require that the annual depreciation be set aside in amount sufficient to retire the investment. They lose sight of the fact that the purpose of depreciation is to maintain the property and not the investment. The Supreme Court of Michigan stated the question tersely in the following language:—"The purpose of permitting a

depreciation charge is to compensate the utility for *property* consumed in service."

As an illustration, take a 500 H.P. boiler installed at a time when the cost of installation was \$10,000, but which must be replaced at a time when its cost of replacement will be \$15,000. In order to keep the *property* intact, the depreciation reserve must amount to sufficient to replace 500 boiler horse power and not \$10,000 which would only provide two-thirds as much capacity. The U. S. Supreme Court recognizes this difference in its decision in the Baltimore Railways case, decided January 6, 1930. The language of that decision is as follows: "The utility is entitled to see that from earnings the value of the property invested is kept unimpaired. . . . This naturally calls for expenditures equal to the cost of the worn out equipment at the time of replacement; and this for all practical purposes means present value. It is the settled rule of this court that the rate base is present value, and it would be wholly illogical to adopt a different rule for depreciation."⁸

CONCLUSION

The foregoing are but a few of the recent trends which have a bearing upon the rate base. Engineers, accountants and attorneys specializing in public utility regulation matters have an obligation to think clearly, present their data concisely and convincingly and to interpret the facts as they may appear. Court decisions reflect the logic with which cases are prepared and presented. The basic advancement in utility appraisal thought as expressed by the Courts has been the result of much intelligent reasoning and presentation of data before it finally took the form of Court decisions.

DISCUSSION

SAMUEL B. MORRIS:⁹ The paper by Mr. Howson is very timely owing to the wide fluctuation which has recently taken place in public utility finance along with all other public and private business. He has quoted many court decisions to indicate the law regarding the fixing of the rate base and the elements of value which should be taken into consideration.

However, the court decisions are not altogether satisfactory. In

⁸ United Rys. & Elect. Co. of Baltimore vs West.

⁹ Chief Engineer and General Manager, Water Department, Pasadena, Calif.

general, they have been written largely upon the basis that unit costs were continuing to advance—and we engineers have all been parties to such decisions in the preparation and submission of valuation reports. Such decision as the O'Fallon case have been heralded as adding ten billions to the valuation of our railroads. Actually there was little of new law in that decision. It was a reassertion of the rule that both historic cost and reproduction cost should be considered in determining the rate base.

While but a few years ago all the utilities were trying to establish reproduction cost as the sole basis of value, conditions now are such as to invite a complete reversal of attitude and a new defense of historic cost as the fundamental basis of value.

Utility rates should not fluctuate widely as would be the case if reproduction cost were the principal basis of value. It is perhaps, a fortunate circumstance that utility commissions and the courts have been so slow in making decisions. Such delays have tended to stabilize the utility rates.

There are many compensating factors which tend to offset each other and to justify a stable rate structure. The present low prices of labor and materials alone would justify a very substantial drop in the rate base, but this is partially offset by the higher cost of money and to a very much greater extent, in most cases, by such a falling off of revenues as to make the rate of return very much below normal. In fact, many of our utilities are suffering from this condition at the present time even where no change has been made in the rate structure.

The more I see of the effect of reproduction cost upon the rate base as a principal standard of value, the more I am inclined to the view that but small consideration should be given to it in determination of rates and a very much greater emphasis should be placed upon historic cost. Such has always been the policy of the California State Railroad Commission. In some instances the actual practical needs of a utility in the way of earnings to meet its fixed charges and to take care of increasing demands of the public have been adopted by this Commission with what might appear to be scant consideration to either the historic cost or the reproduction cost of the utility.

There can be no doubt that there are a number of instances where a utility's physical plant could now be constructed for only one-half of its original cost. But would it be in the public interest to reduce its rates accordingly and further throw its financial structure into chaos in such times of financial stress? The answer is obviously, no.

Public utilities are regulated in the public interest and so as to attract low interest bearing investments. They should be entitled to a fair rate of return upon prudently invested capital.

The public utility commissions have a very great obligation in times of such financial stress as the present to so regulate the rate structure of our public utilities as to permit them to render the public service for which they were created with full fairness to the public and the utility alike. Unregulated business is itself having a most difficult time to maintain stability even though its rates and markets are affected only by economic factors of supply and demand.

It is fortunate in a way, that the courts have been somewhat slow in acting upon rate structures. I imagine that they are not able to take into consideration the changing events at the time of their decisions, as might be understood. I understand the courts can only consider the original data before them and if it takes several years for that to go through they will still have only the Superior Court data before them.

I know in the case of California courts that they can reopen the matter of criminal cases, but not the civil cases.

The Railroad Commission in the State of California has for many years laid its greatest stress upon the importance of historic costs. In order to get a record before them when the Commission first organized in 1910, or 1912, they had a valuation made of all utility plants in California, and began with that reproduction cost. But since that date the appraisals have all been almost entirely upon a basis of historic cost. In one or two cases they have considered the necessary financial earning power of a corporation to take care of its immediate needs and of its outstanding indebtedness, somewhat independent of the physical appraisal, either on a reproduction cost basis, or on an historic cost basis.

It occurs to me that the suggestion which has been made, indicated by court decision, that the depreciation fund had to take care of the replacement of the item at the time it is to be replaced, is a rather fanciful thought and is not really a workable plan. You may, in some instances, be able to determine that the work will cost substantially more when it has to be replaced, if it should be under paving, or some condition of that kind. But in general, while you are writing off depreciation from year to year on the plant that must be replaced fifty years hence, you have not the merest guess as to what the cost will be at that time. Just project yourselves into the past and see

how you could have fore-told the replacements you are now making and their present costs.

I have a feeling that valuation should be stressed more on the historic cost and less on the reproduction cost, both in the matter of determining the rate base and in the matter of setting up a depreciation fund. I think in a way our municipally owned utilities have a little advantage in the fact that they have to write off their indebtedness. I do not know whether that is general in all the states, but I think it is. We have to issue serial bonds which are to be retired and in that way all of the plants that have been established for any substantial period of time have a large portion of their investments written off and are in a better position to face times of stress than are the plants which have two-thirds of their investments represented in bonds and a somewhat uncertain amount of stock issued against the plant in addition.

In our own plant in Pasadena, we operate both a water, and a light and power plant, and we have in each an investment of about six million dollars. We have only \$800,000 worth of bonds outstanding against the water plant and only \$400,000 against the light and power department, so that we are in a very good financial condition to meet the need for new capital required for future developments of water supply or of power.

G. D. KENNEDY:¹⁰ Mr. Howson has not only pointed to the necessity for clear thinking and concise presentation of facts on the part of engineers and others appearing before regulatory bodies, but he has given an excellent example of such a manner of presentation in his own paper.

The demand for lowered utility rates has spread rapidly in the last few months. The public press seems in many places to have taken up the cudgel for lowered rates based on the comparison with lowered commodity prices and industrial earnings, which Mr. Howson has shown to be a false comparison.

In Detroit, Michigan, for example, the question of gas and electric rates has just been opened with the State Public Utilities Commission. Telephone rates have been in litigation for some time and present water rates are being questioned.

It is timely, therefore, to consider the fundamental differences

¹⁰ Civil Engineer, Department of Water Supply, Pontiac, Mich.

between utility and industrial rates. Since recent court decisions have fixed a fair rate of return as based upon cost of reproduction today less depreciation, it also becomes more imperative than ever to consider all controversial elements going into the make-up of the depressed plant valuation or rate base. Here again the author concisely states the items more susceptible to dispute, including overheads, going value and depreciation.

We are indebted to Mr. Howson, therefore, for a handy set of notes which can serve as an index to today's valuation problems.

MR. HOWSON:¹ The point that Mr. Morris makes relative to the Supreme Court, or any court, reviewing matters outside of the evidence, is well taken. I did not mean to so infer, beyond calling attention to what actually happened in the Illinois Bell Telephone Case. In this case the Illinois Commerce Commission on August 16, 1923 entered an order prescribing telephone rates for Chicago. An interlocutory injunction against the enforcement of the rates was secured December 21, 1923. This was affirmed by a three judge Federal Court on Oct. 19, 1925. Appeal was taken to the U. S. Supreme Court which, due to various delays, did not render its decision until December 1, 1930, some seven years after the start of the proceedings. The Supreme Court stated that in addition to the question necessarily presented as to whether the order of the Commission was confiscatory *when made* there was presented the further question of its validity during the period intervening between the date of original hearing and date of final decision.

The Supreme Court stated that the lower courts conclusion as to confiscation "had particular reference to the evidence bearing upon the business of the year 1923. The court said that this finding applied with increasing force to succeeding years. But no findings were made as to the value of the property and the revenues and expenses in these years. In order that the necessary findings may be made, and such additional evidence as may be required for that purpose may be received, the decree is set aside and the cause is remanded to the District Court for further proceedings in conformity with this opinion."

In view of this statement and the further statement in this and other decisions that: "A rate order which is confiscatory, when made, may cease to be confiscatory or one which is valid when made may become confiscatory at a later date" it is believed that courts do

sometimes recognize at least such major variations in price trends as are referred to in the Lincoln Gas decision as "matter of common knowledge that costs of labor and supplies have largely advanced since this cause was last heard in the court below."¹¹

On the question of a base for depreciation: water properties which have an aggregate, or an average over-all, life of fifty or more years do not depreciate from *new* to *zero*. I think I have yet to see a water works property, even though it had originally been constructed as much as forty or fifty years ago, that had an accrued depreciation exceeding as the outside figure possibly 20 percent. Depreciation in a water works property, which is a composite property, proceeds along a series of saw-tooth lines reducing gradually from a new condition of 100 percent to a more or less uniform status of 80 to 90 percent after a period of years. After a property reaches maturity with replacements, additions and betterments going on continuously, I think that it is the usual experience that a substantial level is eventually obtained and that the depreciation accruing annually from that time on will be balanced by the annual replacements. When that condition is reached the accrued depreciation reserve will fluctuate in amount only between rather narrow limits and will ordinarily total somewhere between 10 and 20 percent. In the Indianapolis Case, as I recall it was only computed at some 6.5 percent.

The difficulty which Mr. Morris suggests as to errors that may arise from trying to create a depreciation reserve now for something fifty years ahead, it seems to me is more theoretical than real. A Depreciation reserve should be as flexible as the net return and both based upon the same valuation. The fair net return is based upon the present worth of the property and is adjusted from time to time as the value of the property fluctuates. Experience indicates that privately owned utilities in the past two decades have in general been going through rate proceedings every five or six years, as an average. As a result, the rate base is adjusted for the purpose of fixing return every five or six years and I see no reason why it should not also be adjusted at that time equally well as a basis for depreciation reserves.

I realize that from the accounting standpoint there is some difficulty in basing depreciation allowances upon a changing base.

¹¹ Lincoln Gas Co. vs Lincoln 39 Sup. Ct. 454, 458.

However, the periodic adjustment of the rate of annual depreciation as well as the base to which it applies makes it practicable to maintain the reserve in reasonable conformity with the requirements as determined by an estimate of the accrued depreciation which has occurred to date. It seems the logical way to maintain the *property* rather than the *investment*.

INTEREST DURING CONSTRUCTION

By LOUIS D. BLUM¹

The treatment of interest during construction is well understood from the accounting standpoint. In fact, a definite accounting procedure has been established regarding it. Therefore, in this paper I shall not attempt to suggest any change in the present methods, but merely try to analyze the subject for the benefit of those not wholly familiar with the methods now in use.

ORDINARY COMMERCIAL ENTERPRISE

Interest paid during construction by the ordinary commercial enterprise is charged to the cost of the property constructed. This procedure is invariable and has a logical basis in the accounting axiom that no business of any character can have operating expenses until it begins operation. Therefore, all charges representing payments of interest during construction or as a matter of fact, until the enterprise actually begins operations, are proper charges to capital.

In the foregoing treatment of interest paid during construction, only the interest actually paid or accrued on borrowed capital is contemplated, and no charge to capital representing loss of interest on capital funds during construction has been considered, although in certain cases where uniform cost systems are involved some charge to represent an equilization of capital investment would appear to be desirable. To illustrate this point, let us assume that two corporations are formed for the purpose of manufacturing an identical product and that the plant investments representing factory buildings and machinery are the same in both cases. Corporation number 1 finances its plant through sales of capital stock, while corporation number 2 finances its plant through sales of bonds. It is obvious that corporation number 2 will have a greater capital investment than corporation number 1 because of the cost of interest paid on borrowed money and that, although the two plants have similar locations and facilities and manufacture an identical product, the cost

¹ Certified Public Accountant, New York, N. Y.

of the product will be greater in the case of corporation number 2 than that of corporation number 1, because of the increased cost of capital investment due to interest during construction.

PUBLIC UTILITIES

Interest during construction with respect to public utilities is generally a large item of cost and deserves the most careful consideration. Provision must be made sufficiently far in advance of the time when funds for construction purposes will be required to avoid suspension of such work because of stringency in funds. Therefore, interest must be paid on the money for some time in advance of its disbursement as well as thereafter and usually at a rate considerably higher than can be obtained by placing the funds with depositories until needed. The extent to which interest thus received offsets interest paid is a reduction in the cost of interest during construction.

The cost of interest during construction is ordinarily computed as equivalent to the interest on the total cost of construction (not including interest) for one-half the construction period. This method is based on the assumption that the rate of expenditure remains constant from an investment of zero to one of 100 percent and that interest accrues on expenditures of money only after it is disbursed.

Although the foregoing method of calculating the interest to be charged assumes a constant rate of expenditure from its inception to the completion of the work, this is seldom the case. During the first half of the construction period when the greater part of the materials are purchased, there would be an excess of interest cost over that implied by the foregoing theory. Interest during construction is paid out of capital funds and is therefore as much a part of the investment as the buildings and machinery. Consequently it is just as much a part of capital as the buildings themselves.

The Interstate Commerce Commission defines interest during construction as follows:

Interest during construction should include only such proportion of the interest on funds used for construction purposes and for the discount and expense on funded debt as is equitably assignable to the period between the date of issuance of securities and the time when property acquired or the improvement made through such issuance becomes available for the service for which it is intended. Proportion of interest, discount and expense thus chargeable should be that which the period prior to the completion or coming into service of the facilities or improvements constructed bears to the entire life of the securities issued.

Considered from the standpoint of public utilities, interest during construction acquired added importance for two reasons, first, because of the large amounts involved and, second, because it is a material factor in arriving at a proper rate basis. The various state regulatory commissions have recognized the importance of the proper treatment of interest during construction in the accounts of public utilities and have provided for its treatment in their uniform classification of accounts. The following quotation from the uniform classification of accounts for water utilities prescribed by the National Association of Railway and Utility Commissioners outlines the methods generally followed:

When any bonds, notes, or other evidences of indebtedness are sold, or any interest bearing debt is incurred for acquisition or construction of plant and equipment, the interest accruing on the part of the debt representing cost of the property chargeable to fixed capital accounts (less interest, if any, allowed on unexpended balances) after such fund becomes available for use and before the receipt or the completion or coming into service of the property so acquired shall be included in this account.

When such securities are sold at a premium, the proportion of such premium assignable to the time between the date of the actual issuance of the securities and the time when the property acquired or the improvement made becomes available for service shall be credited to this account.

This account shall include also such proportion of the discount and expense on long term debt issued for construction purposes as is equitably assigned to the period between the date of the actual issuance of the securities and the time when the property acquired or the improvement made becomes available for the service for which it is intended. The proportion of discount and expenses thus chargeable shall be determined by the ratio between the period prior to the completion or coming into service of the facilities or improvements acquired or constructed and the period of the entire life of the securities issued.

This account shall also include reasonable charges for interest during the construction period on the accounting company's own funds used temporarily during such period for construction purposes.

When any of the expenditures above enumerated can be charged directly to the account for which they are incurred they should be so charged and not to this account.

It should be noted that the uniform classification of accounts provides for the inclusion of reasonable charges for interest during the construction period on the accounting company's own funds used for construction purposes. In the case of funds so used the income account credited should be designated "Interest Earned During Construction."

FEDERAL INCOME TAX LAW

Under the Federal Income Tax laws in force at the present time interest charges are allowable deductions from income. The Treasury Department has consistently held that such charges may not be capitalized, except in cases where unproductive property is held for purposes of investment and although it was formerly permissible to add carrying charges including interest to the cost of unproductive property under the Revenue Acts of 1924, 1926, and 1928, this practice was discontinued on August 6, 1931 under authority of Treasury Decision # 4321.

Article 591 of the Revenue Act of 1928 provided that the cost or other basis could be increased by carrying charges such as taxes, etc., although in cases where the taxpayer elected to deduct such carrying charges in computing net income or used such charges in determining his liability for filing returns of income for prior years, the cost or other basis could not be increased by the carrying charges so deducted in computing the gain or loss resulting from a subsequent sale of the property.

Treasury Department Decision # 4321 amends article 591 of the Revenue Act of 1928 as follows:

Carrying charges such as interest and taxes on non-productive property may not be treated as items properly chargeable to the capital account except in the case of carrying charges paid or incurred as the case may be prior to August 6, 1931 by a taxpayer who did not elect to deduct carrying charges in computing net income and did not use such charges in determining his liability for filing returns of income.

It will be noted from the foregoing quotation that the capitalization of carrying charges for Federal Income Tax purposes is permitted only in connection with unproductive property in cases where such charges were paid or incurred prior to August 6, 1931 and only to the extent that such charges were not used in determining the tax liability of prior years.

In the case of the Spring Valley Water Company before the U. S. Board of Tax Appeals "5 BTA. 660," the Board held that interest paid on funds borrowed for the construction of a dam and deducted from gross income in the year in which such interest was paid could not be included in the cost of the dam in determining the deductible loss for Federal Income Tax purposes upon its destruction.

An interesting point regarding interest was recently decided by

the United States Board of Tax Appeals in the case of the New England Power Company. In this case the Power Construction Company, a subsidiary of the New England Power Company, performed construction work for other members of the same affiliated group, the practise being for the New England Power Company, parent of the Power Construction Company, to advance funds to it, from which funds the Power Construction Company made disbursements for wages and materials and supplies for carrying on the construction work. Interest was charged by the parent company on the money so advanced and the Power Construction Company in order to meet such interest charges made a charge therefore as a part of the cost of the work billed to the operating company for which the construction work was performed. The operating company paid for the construction work either out of bank borrowings or from proceeds of the sale of bonds or preferred stock.

During 1919 and 1920 the New England Power Company charged on its books as capital expenditures the sums, respectively, of \$48,213.29 and \$25,474.25, these amounts being interest charged by the parent company on sums advanced to the Power Construction Company. The amounts so charged were not claimed as deductions in the tax returns of the Power Construction Company nor the New England Power Company.

In its decision the Board held as follows:

Interest as such is properly deductible in the year of accrual and it is not a proper capital item. But in this case it does not appear that the petitioner ever became liable for or paid any interest. The loans were made to the construction company and it put itself in position to pay the interest by increasing the cost of the work in an amount sufficient to cover the interest it was required to pay. We see no difference between the situation here and the ordinary case where a contractor borrows funds to prosecute a construction job and figures in the interest he will be required to pay in the sale price he fixes for the completed job. In such case, while the purchaser reimburses the contractor for interest, he does not pay interest as such.

For purposes of Federal Income Taxes, only that interest actually paid or incurred represents an allowable deduction and all charges to capital account representing loss of interest resulting from a calculation representing an estimated return on the company's own funds used in construction must be excluded therefrom. The item therefore of interest earned during construction on company's own funds should

be treated as non-taxable income in the preparation of the Federal Income Tax Return.

Interest capitalized in the books of account must be eliminated from the cost or other basis of property in computing the allowable deduction for depreciation of such property for Federal Income Tax purposes. Interest actually paid whether capitalized or not is a proper deduction from gross income in computing taxable net income for Federal Income Tax purposes.

In conclusion, let me urge upon you the importance of keeping your fixed capital accounts in such form that a complete analysis of these accounts may be made readily available in order that such items as interest during construction and others which may require special treatment for Federal Income Tax purposes may be easily segregated, as many items ordinarily included in the fixed capital accounts must be excluded therefrom in arriving at a proper basis for depreciation, notwithstanding the fact that some of such items represent proper deductions from income.

A columnar fixed capital record designed to segregate the various classes of expenditures for fixed capital from the standpoint of Federal Income Tax requirements will be found to be very helpful in the preparation of Federal Income and other tax returns.

EFFECT OF MAINTENANCE OF METERS ON REVENUES

By D. C. Morrow¹

In the design of rate schedules it is the purpose of water works officials, of both publicly and privately owned plants to distribute equitably the financial burden imposed on water users. If all people had the qualities of honesty and fairness this purpose could succeed whether a flat rate or meter rate schedule were in effect, but often leaking faucets, faulty water closet valves and the general careless use of water are present where meters are not in service. These conditions serve no good economic or sanitary purpose, and in many cases cause shortages of water during periods of protracted droughts which in turn result in expenditures for additional water supplies.

Public opinion is frequently opposed to metering and water works officials who are familiar with its advantages, and who favor it, are compelled to continue flat rate schedules in effect because it is the expedient course to pursue.

In general, it is believed that the only circumstances in which metering would not be justifiable are in plants which have inexhaustible gravity supplies and where the capacities of the transmission and distribution systems would not be overtaxed by unnecessary use of water. Such plants exist only in communities where growth of population has ceased or is receding.

Early in 1928 officials of the Community Water Service Company agreed that the methods of meter repairing in practice at the meter shops of many of the subsidiary companies were not accomplishing the purpose of maintaining in service meters which would measure water within the limits of accuracy prescribed by the various state regulatory bodies. Experience had indicated that most of the men engaged in repairing meters had never received instructions from one experienced in manufacturing shop practice and, therefore, did not appreciate the value of accurate measurements of meter parts.

After securing the services of a man with years of experience, both

¹ General Manager, Washington Water Company, Washington, Pa.

TABLE 1
Effect of meter repairs on revenue

DATE	COMPANY "A"			COMPANY "B"			CONSOLIDATION OF EIGHT COMPANIES		
	Domestic and commercial revenue	Domestic and commercial customers	Meters repaired	Domestic and commercial revenue	Domestic and commercial customers	Meters repaired	Domestic and commercial revenue	Domestic and commercial customers	Meters repaired
<i>1928</i>									
May.....	0.03			0.10			0.12		
June.....	0.36	0.05		-0.34	-1.48		0.05	-0.26	
July.....	0.29			-0.43	-0.49		-0.04		
August.....	0.0	0.0	0.0	-0.51	-0.36		0.0	0.0	0.0
September.....	0.47		1.3	-0.31	-0.71		0.18		0.4
October.....	1.17		3.0	-0.93	0.55		0.01		0.9
November.....	1.67		4.6	-0.35	1.10		0.30		1.3
December.....	1.75	2.02	5.4	-0.71	0.66		0.21	1.63	1.6
<i>1929</i>									
January.....	2.65		6.6	0.10			0.67		2.0
February.....	2.81		7.6	0.0	0.0	0.0	0.65		2.2
March.....	3.10	1.28	9.4	-0.15	0.34	1.8	0.71	1.53	3.6
April.....	4.06		10.0	0.10	1.34	2.4	1.11		4.4
May.....	4.28		10.9	0.58		3.6	1.26		5.5
June.....	5.18	1.44	12.5	1.15	-0.60	4.5	2.13	2.52	7.1
July.....	6.38		13.5	1.17	0.16	5.6	2.64		9.0
August.....	7.65		14.5	1.95	0.52	6.6	3.41		10.1
September.....	8.30	1.72	15.4	3.20	0.84	7.0	4.20	3.48	11.6
October.....	9.10			3.38	1.64	10.0	4.85		13.2
November.....	9.87		16.5	4.08	2.08	11.1	5.47		14.8
December.....	10.63	4.62	17.6	4.46	1.84	14.3	6.05	4.78	16.7
<i>1930</i>									
January.....	10.91		19.1	4.04	1.33	18.4	6.22		18.8
February.....	11.63		19.9	4.63	1.24	19.9	6.70		21.1
March.....	12.00		21.4	5.20	0.79	21.2	7.06	2.74	23.0
April.....	12.08	0.69	23.8	5.31	3.05	23.0	7.31		24.7
May.....	12.62		25.0	6.28		24.1	8.15		27.1
June.....	12.90	1.37	25.7	6.91	2.00	24.8	8.42	3.86	28.2

in manufacturing shop practice and in field repair of meters, a survey of all plants was made with the purpose in view of establishing central repair shops. In deciding on the locations of these shops, geographical location in respect to accessibility of the greatest number of meters was the determining factor.

Shops were equipped with accurate testing devices and with only

enough tools and machinery to readily replace parts. It is believed that the machining of parts can be done more cheaply by meter manufacturers.

Cost of repairing compared with the cost of new meters, less the salvage value of the old meters, determine whether meters will be repaired or scrapped. As an illustration: Assuming the cost of a new meter to be \$9.00, and cost of repairing the old meter to be \$7.50 and its salvage value to be \$1.50, it is at once evident the old meter should be scrapped. Records indicated that many meters were in service which could not be repaired economically. These records further indicated that plant managers first selected all such meters to send to the central repair shops and that succeeding shipments contained fewer meters which had to be scrapped.

Studies of records of meter maintenance, increase in numbers of domestic and commercial customers and increase of revenues in Pennsylvania and West Virginia, made in 1930, disclosed the fact that increases of domestic and commercial revenues due to replacement of meters, either by those repaired or by new meters, warranted expenditures equal to that of replacement by new meters. The result of these studies appear in table 1.

The Company designated Company "A" had in domestic and commercial service at the beginning of the records 10,646 meters; Company "B" 7,313 meters, and the Consolidation of Eight Companies 36,246 meters.

In each company, meters which had been registering remarkably low quantities of water were removed first and in many cases the records of registration of the old meters were compared with those of the replacements. In all cases registration increased and in many, the increases were as high as 300 percent.

After considering the experience which has been recited, the conclusion is that in fairness to companies and departments furnishing water and to customers, all meters should be maintained so that they will always be accurate measuring devices within reasonable limits.

DISCUSSION

MR. E. A. JOHNSON:² In discussing the paper submitted by Mr. D. C. Morrow of the Washington Water Company, Washington,

² National Representative, Pittsburgh Equitable Meter Company, Pittsburgh, Pa.

Pennsylvania, I believe Mr. Morrow has covered his paper so thoroughly from the angle from which he has written it that there is very little need of discussion along this line.

However, I believe that the subject has many angles to it and I desire to present for your consideration the following ideas as to how meterization affects revenues by citing the case of the City of New York.

The report of the City of New York for the year 1928 shows that while the population is 6,100,000, the daily pumpage or consumption of water is 867,000,000 gallons, or a daily per capita consumption of 142 gallons. The annual pumpage is 316,455,000,000 gallons. There are approximately 575,000 water services in the City of New York of which 140,000 are metered, or approximately a little better than 24 percent, with 76 percent of the water services un-metered. The report of the City of New York for the year 1928 shows that their total revenue received was \$23,150,823.18 of which \$11,765,520.18 came from the metered water, or over 50 percent of the total revenue.

The estimated cost of operating the Water Department for 1928 was approximately \$25,000,000, or a deficit of \$1,849,176.22. The estimated cost of supplying water per million gallons was \$78.97 and the revenue received per million gallons was \$73.22, leaving a deficit of \$5.75 per million gallons.

The estimated population of the City of New York in 1930 was 7,000,000 and under the per capita consumption of 142 gallons, the average daily pumpage or consumption would have been 994,000,000 gallons, the total annual water consumption 362,810,000,000 gallons. The normal increase of metered services in the City of New York during this period would be approximately 5,000, making a total of 143,000 metered services with 432,000 un-metered services.

Engineering figures show that, if the City of New York had been universally metered by the year 1930, the average daily consumption per capita would have been 100 gallons, the total daily pumpage would have been 700,000,000 gallons and the total annual pumpage 255,500,000,000 gallons. This water could have been sold at the price of water in New York in 1928 at 13 cents per 1,000 gallons, which would have brought in a revenue of \$29,983,500. The cost of operating the Department under this low per capita consumption, using the 1928 figures as a basis, would have been \$20,176,835, or a net estimated gain to the Water Department of \$9,616,665 for the

year 1930 with 100 percent meterization, as against a loss of \$1,849,176 for the year 1928 with only 24 percent of the City metered.

In a recent appeal of the City of New York before the United States Supreme Court, Special Master Charles N. Burch stated that the City of New York was in urgent need of additional water resources and he recommended that the Court allow the City of New York to divert 440,000,000 gallons of water daily from the Delaware River. It is estimated that it will cost at least \$300,000,000 and will consume at least ten years time in constructing the necessary water sheds and laying the necessary pipe lines. Had the City of New York been 100 percent metered in 1930, or even at the present time, the saving of water under 100 percent meterization would have been approximately 400,000,000 gallons daily and these 400,000,000 gallons of water are available immediately, whereas the Delaware River supply is approximately ten years off in the future. The capital cost of metering the entire City of New York based on gallons of water now available in reservoir would be approximately 3 cents per gallon whereas the capital cost of delivering the 440,000,000 gallons of water from the Delaware River is approximately 68 cents per gallon. I believe these figures are a self-evident fact as to the advantages of meterization in revenues.

The City of Philadelphia presents an almost similar case, except that they are not drawing their water from such a great distance as New York City is by taking it from the head-waters of the Delaware River. The daily per capita consumption in the City of Philadelphia is approximately 157 gallons and the total daily pumpage is approximately 350,000,000 gallons.

Engineering estimates indicate that this per capita consumption would be reduced to approximately 100 gallons which in turn would mean that the City's present water plant would be pumping approximately only 200,000,000 gallons instead of 350,000,000 gallons at the present time.

In Philadelphia, with a population of approximately 2,000,000 there are 450,000 taps and 180,000 meters, or approximately 40 percent metered. The figures for the year 1930 in the City of Philadelphia with 40 percent metering show a net revenue to the City of \$3,725,000, whereas if the City of Philadelphia were completely metered, the net revenue would be \$7,121,000 or almost double the present revenue.

The City of Baltimore illustrates exactly the same case, except

that in Baltimore, a smaller city, the figures of saving or increase of revenue through meterization would run on the same percentage basis, but in dollars and cents would not equal the tremendous figures for the cities of New York or Philadelphia.

This same rule applies to all large cities and in the City of Pittsburgh, where they have recently started on a five-year program of universal metering, they have already seen results of the saving in their pumpage, which is, of course, increasing revenue and at the same time the cost to the individual consumer has declined over what it was at the flat rate.

MR. L. D. GAYTON:³ At last year's convention in Pittsburgh, I called attention to the necessity for a campaign of education preliminary to any attempt at universal installation of meters in any locality where there was wide-spread opposition to universal metering. I should like to add a little to what I said at that time.

In certain residential sections of Chicago there are instances where meters have been installed at the request of the property owners in connection with small residences and where the cost of water amounts to \$6 or \$7 per year, assessed at the usual meter rates, whereas the cost would be from \$12 to \$14 per year if assessed on the so-called frontage basis. The low cost of water to these properties has no doubt induced others in the immediate vicinity to install meters.

Before attempting universal metering, it might be well to install meters in connection with selected properties in various parts of the city, where the property owner was paying for water upon a frontage basis. These meters should be installed with the permission of the property owner and with the understanding that, if the meter proved unsatisfactory, the owner would have the privilege of returning to the frontage basis. Of course, these meters should be installed only in connection with property where the plumbing was in first class condition.

Some years ago, when universal metering was attempted in the City of Chicago, meters were first installed in the poorer sections of the City where the plumbing was in very poor condition and the resulting waste of water was very great. In one case, where the owner was receiving \$25 per month for a simple cottage, his bill for water after a meter was installed, was over \$50 for one month. In

³ Assistant City Engineer, Chicago, Ill.

many cases such as the one mentioned, the buildings were old, the plumbing worn out and the owners could not afford to make repairs, therefore, great opposition to metering developed.

It would have been better if a few properties had been selected, the plumbing put in proper condition and the people given a practical demonstration in order that they might compare the cost of water on the meter and on the frontage basis and then decide for themselves which they preferred.

A MEMBER: Do you inspect the plumbing before you do that?

MR. GAYTON: Yes, plumbing is inspected before the installation of meters, but when universal metering was attempted some years ago, meters were installed regardless of the fact that the plumbing was in poor condition. The idea, of course, was to force the owner to repair his plumbing and thereby eliminate the waste and the high water cost. Once more returning to the idea of a campaign of education, it might be possible to convince people, living on the outskirts, that meters would assist in eliminating low pressure areas during extended periods of hot weather. To sum it all up, I believe that in cities where the people have the final decision, a systematic campaign of education must be carried out in order to prove the advantages of meters before universal metering can be consummated without great opposition.

THE EFFECT OF SIZES AND MAINTENANCE OF METERS ON REVENUES

By LORAN D. GAYTON¹

On December 31, 1931, there were in the City of Chicago, 427,850 water services and of these, 101,999, or 23.84 percent, were metered.

During 1931 the Chicago water supply system delivered, within the City limits, 363,028,977,206 gallons of water. Of this pumpage 120,287,237,953 gallons, or 33 percent, was metered. In addition, 55 to 60 percent of the total metered consumption passed through less than 3000 meters (4 percent of the total numbers of meters in 1929).

The average daily pumpage in 1931 was 994,599,937 gallons, giving an average of 2324 gallons per tap and 282.56 gallons per inhabitant.

The revenue derived from frontage, or assessed rates, was \$4,068,743.00 and the revenue derived from metered consumers was \$8,951,442.00. In other words, 68.7 percent of the income from the water supply system was paid by metered users.

The foregoing statistics indicate the importance of meters in connection with the revenue from the water supply system and the necessity for keeping these measuring devices in such condition that they will correctly register the amount of water delivered, for, as the greater part of the revenue comes from the metered consumer, any under-registration of the measuring devices would greatly reduce the revenue of the department.

Prior to 1925 the size of the meter to be installed in connection with any premises was arrived at by considering what had been done in the past. In almost every case, also, the owner of the property insisted that as large a meter as possible be installed in order that the loss of head through the meter should be as low as possible. In the past architects have given little consideration to the loss of head in the plumbing and fixtures inside a building, and whenever there was insufficient pressure of water in the upper stories the first complaint

¹ Assistant City Engineer, Chicago, Ill.

was against the meter, claiming that it was too small and restricted the flow of water. In investigating these complaints it was found in almost every case that the loss of head was very little and that the real trouble was with the piping and fittings within the building.

Prior to 1925 very little attention had been given to the rates of flow through meters other than those from which complaints of loss of head had been received. In 1925 one crew was assigned to make investigations and tests of the larger sized meters in order to ascertain whether or not these meters were correctly registering at the rates of flow at which water was actually being used by the consumer.

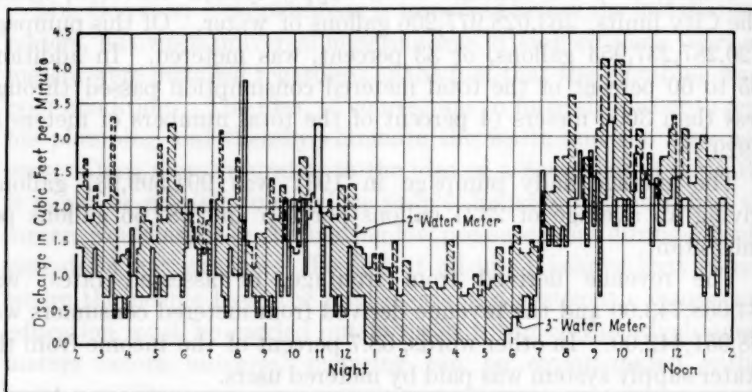


FIG. 1. A twenty-four hour test of a 3-inch meter supplying one three story building containing 56 apartments and a test upon a 2-inch meter which replaced the 3-inch meter supplying the same premises. These tests showed a 34 percent increase in registration by replacing the 3- with a 2-inch meter.

Twenty-four hour records of actual usage rates were obtained with one flow recorder, and during 1925, out of 79 meters so tested, 21 changes in size were recommended. No exact record was made at this time of the saving brought about by the change of meter, but the work done in 1925 indicated that there was a great need for a thorough and systematic check-up as to the correctness of registration of all large meters in the City.

MASTER FLOW RECORDING METERS

In 1926 a new master flow recording meter was designed and eight machines of this design were constructed in the City's shops.

This master flow recording meter consists of a series of electro-

magnet operated levers, controlled by a special recording register, which can be attached to any meter under investigation. These levers print a permanent record on a ribbon tape. The record of any desired length of time may be obtained; usually one for twenty-four hours will give all the information necessary, but in case a longer

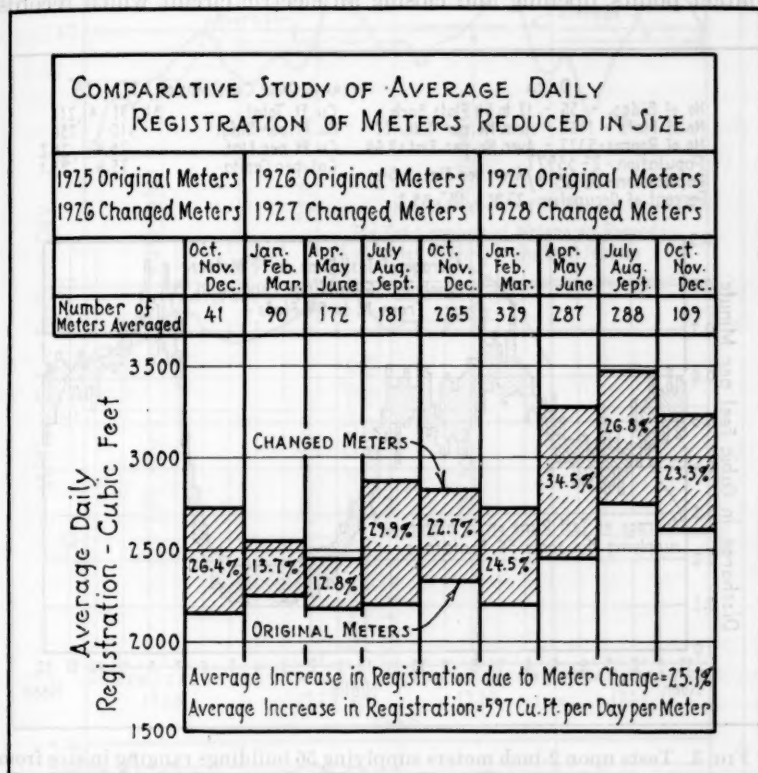


FIG. 2. Shows consumption records over a period of years in cases where 3-inch or larger meters were replaced with meters of smaller size. An average increase in registration resulted of 25 percent where 3-inch meters were replaced with smaller size meters.

record is desired it is not necessary to change the chart as the recorder will run a week before it is necessary to change the record roll. In the case of compound meters, or when meters are set in pairs, the two records may be obtained simultaneously.

The connection of the recorder to a meter is simply and quickly

made. First, the regular register and change gears are removed from the meter; a short driving pawl is connected to the train gear shaft and a special register attached. This register contains a contact arm which revolves with the movement of the train gear shaft. During one revolution of the shaft this contact arm passes over ten contact points, opening and closing an electric circuit which records

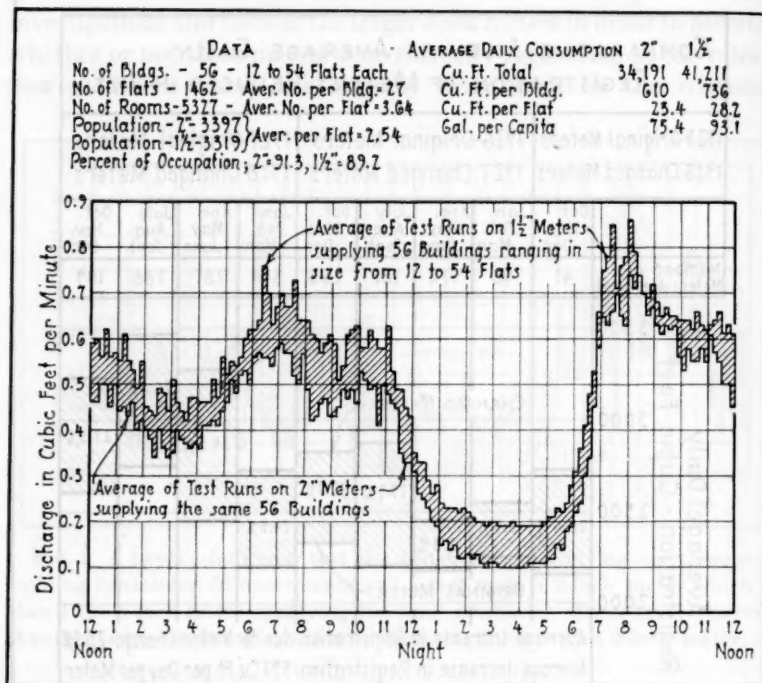


FIG. 3. Tests upon 2-inch meters supplying 56 buildings ranging in size from 12 to 54 apartments and tests upon the same buildings after the 2-inch had been replaced with 1½-inch meters. An average increase in registration of 23½ percent resulted and shows that the night registration was practically doubled.

the contacts, as will be explained. The recorder box contains a clockworks which controls a constantly moving paper tape on which the record is printed by two tickets (similar in operation to those on a telegraph instrument), which are connected by rubber covered wires to the recording register. The electric current required is furnished by dry cells carried in the machine itself. The tape travels at a uniform rate of one inch in ten minutes, thus a twenty-four record is

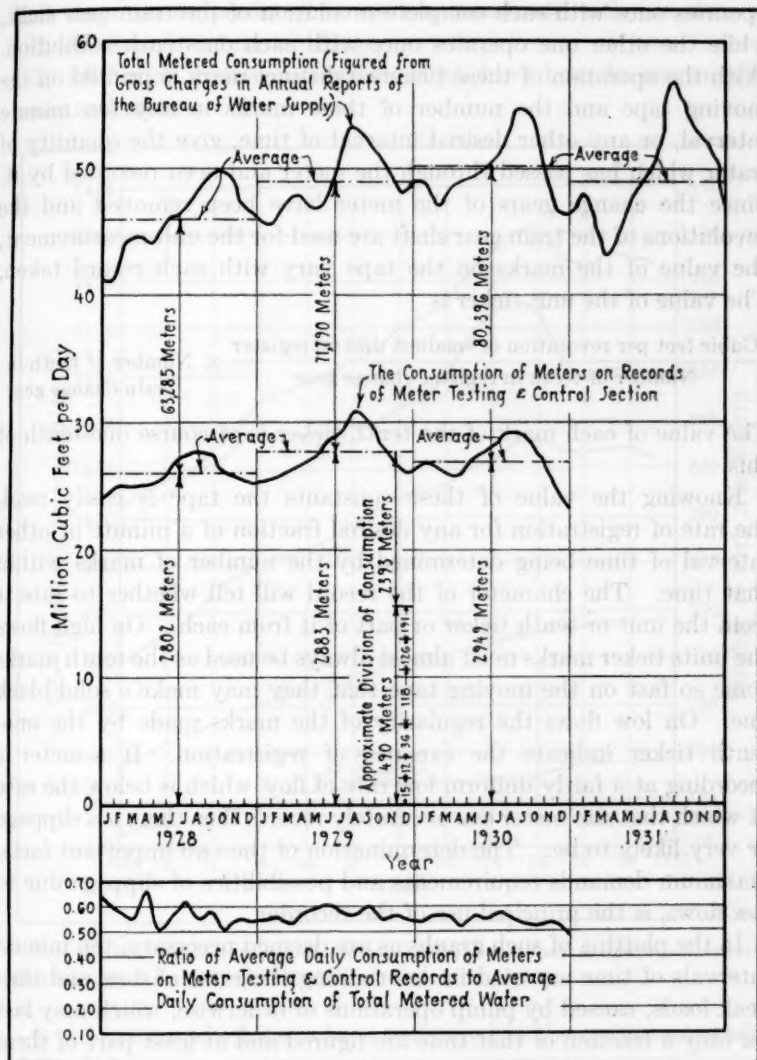


FIG. 4. The total metered consumption in the City from 1928 to 1931 and also the total consumption of the meters on the records of the meter testing and control section from 1928 to 1930 inclusive. From 50 to 60 percent of the total metered consumption of the City passes through less than 3000 meters (in 1929 this was approximately 4 percent of the total number of meters).

twelve feet long. The tickers are so connected that one ticker operates once with each complete revolution of the train gear shaft, while the other one operates once with each one-tenth revolution. With the operation of these tickers a distinct mark is printed on the moving tape and the number of these marks in any ten minute interval, or any other desired interval of time, give the quantity of water which has passed through the meter and been recorded by it. Since the change gears of the meter have been removed and the revolutions of the train gear shaft are used for the unit measurement, the value of the marks on the tape vary with each record taken. The value of the unit ticker is

$$\frac{\text{Cubic feet per revolution of smallest dial on register}}{\text{Number of teeth in register change gear}} \times \text{Number of teeth in train change gear}$$

The value of each mark of the tenth ticker is of course one-tenth of this.

Knowing the value of these constants the tape is easily read, the rate of registration for any desired fraction of a minute or other interval of time being determined by the number of marks within that time. The character of the record will tell whether to rate it from the unit or tenth ticker or part of it from each. On high flows the units ticker marks must almost always be used as the tenth marks come so fast on the moving tape that they may make a solid black line. On low flows the regularity of the marks made by the one-tenth ticker indicate the evenness of registration. If a meter is recording at a fairly uniform low rate of flow which is below the rate at which that size meter can accurately record, then there is a slippage or very likely to be. The determination of the two important facts, maximum demands requirements and possibilities of slippage due to low flows, is the principal use of the recorder.

In the plotting of such graphs as are deemed necessary, ten minute intervals of time are used in determining the rates of flow and then peak loads, caused by pump operations or otherwise, which may last for only a fraction of that time are figured and at least part of them shown on the graph.

These recorders were finished about July 1, 1926 and they were at once put into service with the idea of checking the flow in all meters of 3 inches and over in size. In order to carry out this work of testing, the following was used as a guide to determine what meters should be tested:

1. All meters which showed from readings in the Bureau of Water that the revenue produced is not commensurate with the size.
2. All 8-inch meters and larger.
3. All 3-inch meters and larger which have been in service three years and more.

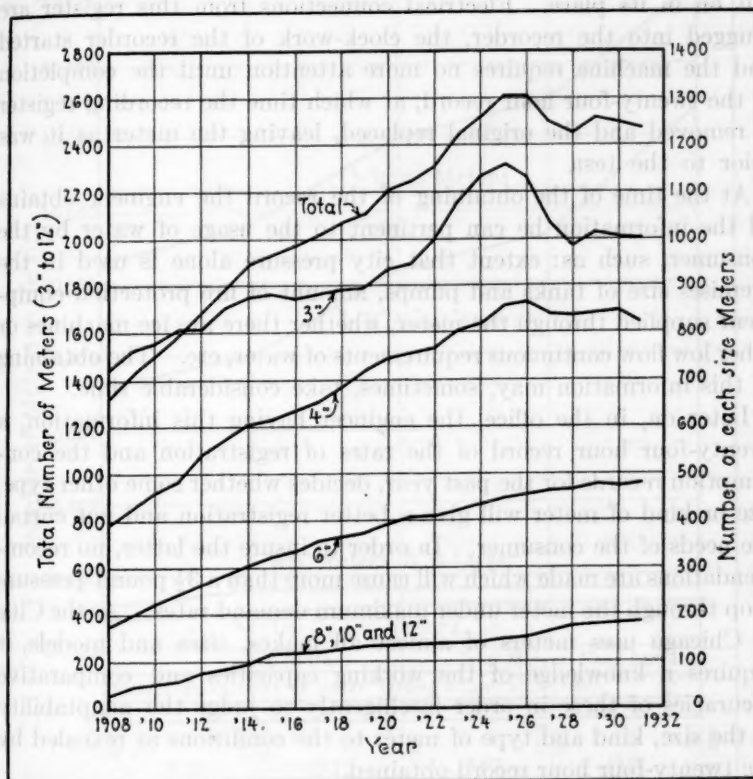


FIG. 5. The total number of meters and the number of meters of various sizes installed in the City of Chicago.

4. All meters which have been registered to the maximum reading of the dial.
5. All meters where request was received for test.
6. All 3-inch meters and larger where it was shown from examination of readings taken by the Bureau of Water that there had been a marked decrease in the amount of water recorded from month to month.

One party consists of a junior engineer, laborer and a light truck. Six or eight recorders are carried by the party and from four to six twenty-four records obtained daily. It only takes a few minutes to make the actual connection of a recorder to a meter.

The original register is removed and a special recording register put on in its place. Electrical connections from this register are plugged into the recorder, the clock-work of the recorder started and the machine requires no more attention until the completion of the twenty-four hour record, at which time the recording register is removed and the original replaced, leaving the meter as it was prior to the test.

At the time of the obtaining of the record the engineer obtains all the information he can pertinent to the usage of water by the consumer, such as: extent that city pressure alone is used in the premises size of tanks and pumps, amount of fire protection equipment supplied through the meter, whether there are ice machines or other low flow continuous requirements of water, etc. The obtaining of this information may, sometimes, take considerable time.

Later on, in the office, the engineer having this information, a twenty-four hour record of the rates of registration and the consumption records for the past year, decides whether some other type, size or kind of meter will give a better registration and not curtail the needs of the consumer. In order to insure the latter, no recommendations are made which will cause more than a $3\frac{1}{2}$ pound pressure drop through the meter under maximum demand rates. As the City of Chicago uses meters of almost all makes, sizes and models, it requires a knowledge of the working capacities and comparative accuracies of these in order intelligently to judge the adaptability of the size, kind and type of meter to the conditions as revealed by the twenty-four hour record obtained.

After a record has been obtained by means of the flow recorder of the rates of flow of water through the meter, it is then possible to determine if the meter is registering correctly, or if it should be replaced with a meter of the same or different size or type.

RESULTS OF TESTING METERS

The work of testing meters was done by designated areas as much as possible. Flow records were taken and recommendations made first on meters in the Stock Yards District, then on meters supplying

flat buildings in residential sections, and after that, in the loop district.

In carrying out our comprehensive investigation of meter registra-

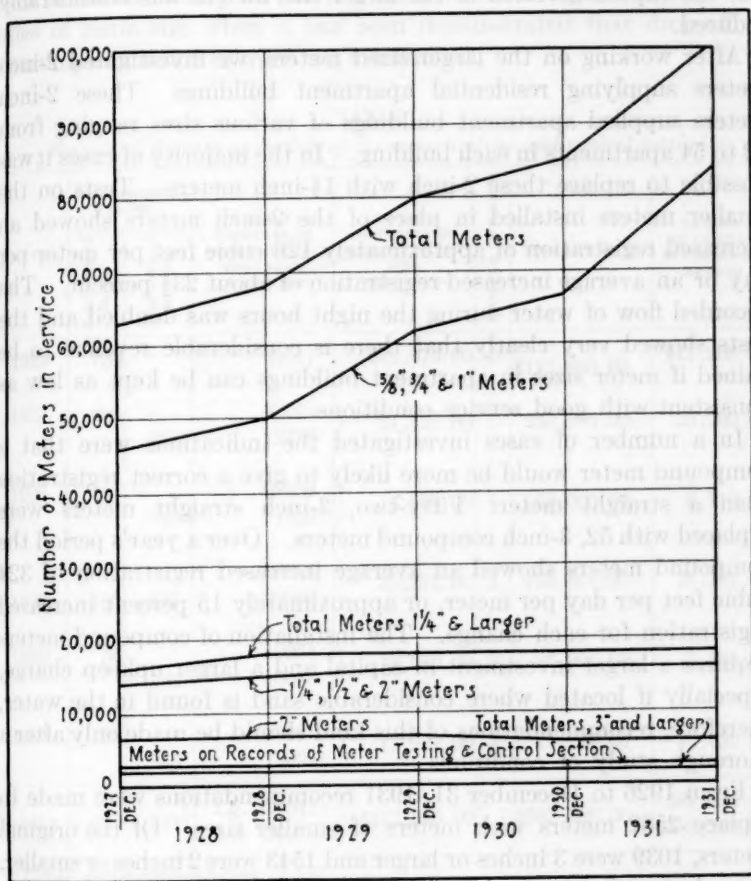


FIG. 6. The total number of meters 3- to 12-inches in size installed in the City of Chicago from 1908 to 1931. The decrease in the number of 3-inch meters from 1925 to date is due to the work carried out by the Meter Testing and Control Section.

tion, we first tested all meters 3 inches in size and larger. In the case of about 25 percent of the meters investigated, 3 inches and larger, it was found possible to change to a smaller size without detriment to the service. Tests on the smaller meters installed in place of

meters 3 inches and larger showed an average increase of registration of 600 cubic feet per meter per day, or an average increase of about 25 percent. Not only was there a marked increase in registration, but the capital invested in the larger size meters was considerably reduced.

After working on the larger sized meters, we investigated 2-inch meters supplying residential apartment buildings. These 2-inch meters supplied apartment buildings of various sizes ranging from 12 to 54 apartments in each building. In the majority of cases it was possible to replace these 2-inch with 1½-inch meters. Tests on the smaller meters installed in place of the 2-inch meters showed an increased registration of approximately 126 cubic feet per meter per day or an average increased registration of about 23½ percent. The recorded flow of water during the night hours was doubled and the tests showed very clearly that there is considerable revenue to be gained if meter sizes in apartment buildings can be kept as low as consistent with good service conditions.

In a number of cases investigated the indications were that a compound meter would be more likely to give a correct registration than a straight meter. Fifty-two, 3-inch straight meters were replaced with 52, 3-inch compound meters. Over a year's period the compound meters showed an average increased registration of 324 cubic feet per day per meter, or approximately 15 percent increased registration for each change. The installation of compound meters requires a larger investment in capital and a larger upkeep charge, especially if located where considerable sand is found in the water, therefore, recommendations of this kind should be made only after a thorough study of conditions.

From 1926 to December 31, 1931 recommendations were made to replace 2582 meters with meters of smaller sizes. Of the original meters, 1039 were 3 inches or larger and 1543 were 2 inches or smaller. By reducing the size of these meters the City has increased its revenue over the period from 1926 to 1931 by \$583,298.00. If we consider the first cost of the smaller meters, in relation to the first cost of the larger meters, there has been another saving of \$87,000.00. Details of these expenditures are shown in table 1.

In addition to the gain from increased revenue and decrease in capital costs, this investigation of meter registration has brought about a further gain to the City due to the closing and sealing of some meters, collections from consumers on back bills rendered which might

not have been collected except for the evidence furnished by the Meter Testing and Control Section, that the charge was fair, benefits derived from the answering of customers complaint of high water bills or unsatisfactory service and from orders to replace meters with ones of same size when it has been demonstrated that drop-off in consumption is due to worn out mechanism.

TABLE 1

Results of 6 years operation of the meter testing and control section.

YEAR	RECOMMENDATIONS		YEARLY INCREASE IN CONSUMPTION, THOUSAND CUBIC FEET	YEARLY INCREASE IN REVENUE \$0.51 PER THOUSAND	NUMBER OF YEARS	TOTAL TO DATE	SAVING IN CAPITAL INVESTED IN METERS
	3 inches and larger	2 inches and smaller					
1926	169		37011	\$18,875.00	6	\$113,250.00	\$11,200.00
1927	402	278	88038 12788	51,421.00	5	257,105.00	23,200.00
1928	131	37	28689 1702	15,500.00	4	62,000.00	6,719.00
1929	182	637	39858 29302	35,272.00	3	105,816.00	28,101.00
1930	56	328	12264 15088	13,950.00	2	27,900.00	7,164.00
1931	99	263	21681 12098	17,227.00	1	17,227.00	10,630.00
Total..	1,039	1,543	Lg. 227541 Sm. 70978	\$152,245.00		\$583,298.00	\$87,014.00 \$583,298.00

Total recommendations: 2,582.

Total increase of revenue and saving in meter investment: \$670,312.00.

Changes made to December 1931: 2,255.

The Meter Testing and Control Section spends approximately \$35,000.00 per year in carrying out this work. So from 1926 to the end of 1931, approximately \$210,000.00 has been expended and for this expenditure the City has received over \$583,000.00 in increased revenue. These figures indicate clearly the necessity and the value of the systematic checking of meter registration.

GUARANTEE PAYMENT OF WATER BILLS

BY JACOB SCHWARTZ,¹ M.E., LL.B.

Since a public service corporation is engaged in a business affected with a public interest and since one of the necessary obligations of such a corporation is to supply without discrimination all persons desiring service in its prescribed territory, therefore, some means had to be devised to afford some measure of protection against unusual losses due to failure, willful or otherwise, to pay legitimate bills for service. The customers of a public service corporation as a whole have definite and tangible interest in this matter, since uncollectible accounts are considered in most states to be a proper charge to operating expense and consequently have a direct bearing upon the rates for service.

To minimize losses resulting from non-payment of bills, resort has been had generally to either prepayment, a deposit to guarantee payment of bills, or a guarantee by a responsible party known to the utility. Prepayment lends itself better to cases where service is sold on a flat rate or unmeasured basis or where the amount of the bill is readily determinable in advance. A deposit to guarantee payment appears to have found favor in cases where service is supplied on a measured basis. A personal guarantee involves many complications in ultimately obtaining payment and also has a tendency to cause the company to lose the good will of the guarantor. The law varies in many states with respect to collecting on guarantee contracts, it being frequently held that you are required to exhaust your legal remedies against the primary obligor before you can look to the guarantor for payment. Since a deposit to guarantee payment of bills has been construed as a fund which may be resorted to whenever the depositor is in default, it is clear, therefore, that this method of securing payment eliminates the usual legal complications involved in a personal guarantee contract.

While the deposit theory generally has the approval of regulatory bodies throughout the land, the application of the deposit system

¹Public Service Commission, Newark, N. J.

has many limitations and restrictions. Let us first consider who may be required to make a deposit. The extremes are naturally the cases where no consumer is required to deposit and where an attempt is made to obtain a deposit from all customers. The former is a matter entirely within the discretion of the company, but the latter has been held to be against public policy and in conflict with the accepted principle that a company may not base a rule presupposing the dishonesty of all its customers, but has a right to adopt a rule which while giving the honest customer what he pays for will prevent the dishonest customer from getting what he will never pay for. It follows therefore that a company may request a deposit from any customer whose credit has not been established with the company.

CUSTOMER'S CREDIT

Whether a customer's credit has been established has been regarded a question determinable by the interested company, whose decision the regulatory bodies would not disturb unless partiality, discrimination, or abuse of discretion was shown on the part of the company. Since bills due and owing to a privately owned water utility are not a lien upon the realty and since adequacy of equity in realty is often difficult to determine, in recent years the tendency has been to consider both the tenant and the owner on a par as far as extension of credit is concerned; the determining factor being whether the customer had established his credit with the company. It has also generally been held that an old customer in default may be required to furnish a deposit to secure payment of future bills. Also, if a customer has established his credit and later defaults he may be required to furnish a deposit.

Inasmuch as a company is permitted to obtain deposits from customers who had not established their credit with the company, a thought should be given to the method by which a customer may establish his credit. At this point it should be again pointed out that the responsibility for determination of credit status is largely a matter of the exercise of proper discretion by the company's representatives, since it is of necessity a very difficult practical matter for regulatory bodies to define specifically the conditions which will constitute establishment of credit. The regulatory bodies, however, represent a haven to which a customer may resort, if he feels the company's decision improper, arbitrary or oppressive.

Some companies will voluntarily establish service to all new customers without request for deposit. Others require all new customers not previously known to the company to furnish a deposit as a condition precedent to the establishment of service. Still another school of thought involves immediate establishment of service upon application giving the customer the option of furnishing a deposit or credit references. If, upon subsequent investigation, credit information is found satisfactory, the deposit is waived.

While decisions are not numerous, it has been held that a new customer making a deposit will be considered as having established his credit by prompt payment of bills for service for a period of 1 to 2 years. It has also been recognized that credit once established shall extend to service at any location within the area of company furnishing the same, and shall not be regarded as restricted only to the particular location where credit was established. Along this line of thought, a company which requests a deposit from a customer whose credit was once established, is charged with the responsibility of affirmatively demonstrating that the customer's credit has become impaired.

In connection with abuse of discretion or discrimination in deposit requirements, it has been held that a company may without improper discrimination extend credit to prompt payers and withhold it from others; also that for unlawful and unreasonable discrimination to exist it must appear that conditions with respect to consumers required to deposit are identical with conditions with respect to those not so required.

SEASONAL OR TEMPORARY SERVICE

The validity of a deposit for short term seasonal or temporary service is generally supported by regulatory opinions and represents recognition of difficulties in obtaining payment often experienced in supplying the classes of service referred to. Deposit requirements in seasonal communities or resorts present some considerations in addition to ordinary credit factors. In such communities it is frequently the experience that a large number of customers will leave at approximately the same time (e.g. Labor Day). Even with most careful planning it is a difficult matter to obtain final readings and prepare bills prior to customer's leaving. The seasonal customer troubled with innumerable details at the close of his vacation period generally forgets utility bills and is apparently satisfied to permit

this item to wait until the service is again desired the following season. In some instances, revenue outstanding at the close of the season will represent a very large percentage of the gross. Under these circumstances there is apparent authority for a general deposit requirement from all customers; waiving the requirement in only those cases where in previous years a customer cleared his account at the end of the season.

AMOUNT OF DEPOSIT

A factor of considerable importance in any deposit scheme is the reasonableness of the amount of the deposit. Since the function of the deposit is to protect the company from losses by unsecured extension of credit, it is clear that the amount of the deposit must bear a reasonable relationship to the amount of credit expected to be extended. Regulatory bodies have adopted various rulings designed to assure the proper relationship between the amount of the deposit and the amount of credit to be extended. The amount of service which a new customer will purchase is not always readily determinable. This factor, however, governs the amount of credit to be extended and in turn the amount of the deposit; consequently some reasonable approximation must be made by observing the number of fixtures, the type of house, etc.

In determining the amount of the initial deposit, it might be well to re-state some propositions generally adopted and adhered to by several regulatory commissions. First, the amount of the deposit shall be reasonably related to the probable charge for service during a billing period; this period to include the average time required for collection after bills are rendered. Where a new customer applies for service, the initial deposit shall be the amount of the average bill of the customers of his class for a given billing period increased by one month's average bill for customers billed monthly or quarterly. If the actual bills of the customer subsequently rendered prove that the deposit is either insufficient or too much, the deposit may be changed in accordance with the facts. It is not possible to formulate any definite ruling to determine the amount of the deposit for commercial or industrial enterprises due to peculiar circumstances involved in each individual case. As a result the companies are generally given some latitude in negotiating for deposits with commercial or industrial consumers. It is the duty of the applying customer to answer all questions which will aid in arriving at a fair

approximation of the amount of service to be used. The amount of the deposit requested together with supporting data upon which it is based, is subject to review by the regulatory body in the event of a dispute. It has been found advisable in such cases to procure readings of the meters at frequent intervals during the initial service period to determine whether the original deposit bears a reasonable relationship to the amount of usage of the utility's service.

DEPOSIT FROM INDUSTRIAL CUSTOMERS

Due to existing conditions during the past few years, many utilities have been requesting deposits from old industrial or commercial customers heretofore supplied without deposit. The request for the deposit is apparently due to apprehension, resulting from failure to pay bills with customary promptness. Strangely enough the habitual slow payer frequently worries the credit manager less than the usual prompt payer who omits a payment. It is clear that the requirement of a sizeable deposit from a commercial enterprise under existing conditions places the customer in an embarrassing position and has a tendency to deplete the amount of working capital available for the conduct of his business. Recognizing these factors as well as the apparent right of the utility to some protection in the extension of credit to commercial enterprises, there has been a tendency to reduce the billing period from quarterly to a monthly or weekly basis and thus effect a reduction in the amount of credit extended. Such arrangements generally work out satisfactorily to both the customer and the company.

RETURN OF DEPOSIT

There has been apparently some change in recent years with respect to the return of deposit to guarantee payment of bills. The old practice involved the retention of the deposit until the service contract terminated. Since the purpose of the deposit is merely to offer a guarantee to the company until such time as the customer establishes his credit, decisions of regulatory bodies hold that once credit has been established, the customer is entitled to a return of his deposit. In New Jersey it is held that a customer establishes his credit by prompt payment of bills for a period of approximately two years. This appears to be a sufficient period for a utility to satisfy itself of the customer's credit status.

INTEREST ON DEPOSITS

Interest on deposits has frequently been a bone of contention and decisions vary considerably with respect to the amount of interest to be paid. It is generally recognized, however, that since money obtained from deposits is considered a trust fund and, is subject to withdrawal at intervals not wholly controlled by the company, it has some of the attributes of demand money and consequently bears a somewhat lesser rate of interest than the usual legal rate. It has been held in some jurisdictions that the rate of at least 4 percent per annum be paid on all deposits with the proviso that interest need not be paid if service is short-termed or seasonal. The payment of interest upon deposits presents a practical problem in accounting practice, since the average customer's deposit is rather small. It is frequently argued that the expense involved in forwarding the customer checks or credit slips for interest payments at regular intervals would create an expense out of proportion to the amount of money involved. There are, therefore, not many specific regularities requiring remittance to consumers for interest payments on deposits at regular intervals. A better rule appears to be that the customer shall have the option of obtaining interest upon his deposit upon its return or may on special request receive interest payments not more frequently than once a year.

CONCLUSION

In conclusion, it would appear that, while a public utility company has a general obligation to supply its chartered territory, it may refuse service without deposit, to a customer who has not established his credit with the company. While discriminatory, preferential or unreasonable regulations may not be imposed as a condition precedent to establishment of service, reasonable rules and regulations may be enacted for the protection of both the utility and its customers generally.

MATERIAL CONTROL POLICIES

BY C. J. ALFKE¹

Waste in industry is responsible for a high percentage of business failures. Waste must be paid for in cash and directly reduces net income by the full amount of such waste. Lack of material control or inefficient material control is one of the largest channels of waste in industry.

Below are listed seven advantages of material control:

1. Prevents losses through check and inspection of incoming material. Shortages and broken or damaged goods are detected. Cracked cast iron pipe or fittings are sometimes accepted unless carefully examined. Merchandise that does not meet specifications is detected, namely: copper tubing or brass pipe not properly annealed will in all probability have to be replaced subsequent to installation if this fact is not detected before it is put in the ground. Proper inspection of materials should reveal materials of inferior quality.

2. Eliminates waste by providing proper storage facilities for materials. A proper material control system should provide for adequate storage and protection of all materials, also storage of material in an orderly manner to facilitate handling and minimize the amount of handling. Space will also be conserved if material is stored in an orderly manner.

3. Prevents over-buying and the consequent tying up of cash unnecessarily in inventories by associating buying with requirements. A list showing minimum and maximum quantities to be on hand of types and sizes of materials also tends to prevent over-buying.

4. Aid to Standardization. Cuts down needless varieties of materials such as different brands of wrenches, shovels, etc. and materials on hand are used where possible as a substitute for material of a type requisitioned but not in store.

5. Prevents delays in installation of mains, hydrants, services or meters, etc. by keeping a sufficient stock on hand at all times. The minimum and maximum list is quite an aid in this respect.

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6. Provides for Perpetual Inventory Record and the taking of frequent physical inventories thereby keeping a close check on and physically accounting for materials.

7. Is an aid to properly recording on the general books material issued as to the proper capital or expense items and affords a check of material received against purchase orders.

LOCATION AND NUMBER OF STORE ROOMS

The location and number of store rooms or yards will depend on:

1. The location of purification and pumping stations and the number of points from which the construction and operating men operate.
2. The space available.
3. The territory covered.

Wherever possible stores should be centralized and kept in one location. If more than one storeroom or yard is necessary they should all be put under the jurisdiction of the General Storekeeper and the responsibility definitely fixed. It is economical at times, in view of the handling cost saved, to locate stores where they are to be used. For instance, purification and pumping plant materials must be located at the stations. Therefore, if they are located quite some distance from the General Storeroom and Yard one or more additional storerooms or yards will be necessary. If the territory supplied by the utility covers a large area in square miles, so that it becomes necessary for construction and operating men to operate from more than one point, a yard will be desirable at each point.

ARRANGEMENT OF MATERIALS IN STORE ROOMS AND YARDS

Materials should be arranged in store rooms in bins by types and sizes. It is an aid to handle materials in store rooms in bins not higher than 6 feet so that no ladders or stools are necessary to get the material. Bin space should be permanently provided for different types and sizes of materials taking into consideration the activity of such types and sizes of materials and locating such active materials in the store room where they can be handled in and out with a minimum amount of carting through the store room. Material ordinarily stored in the yard, namely, outside of the store room should be assigned permanent space in the yard taking into consideration convenience for handling in store and the frequency of issue. The orderly storing of material in the store rooms and in the yards is a

material aid in keeping handling down to a minimum, conserving space, in ordering additional supplies and in inventory taking.

The following are six steps necessary in a Material Control System

1. *Authority to make out purchase requisitions should be limited* as much as possible and only department heads should be authorized to issue purchase requisitions. This should have the effect of holding down purchases to requirements and placing the responsibility for such purchase requisitions on one man in each department.

2. *Purchasing should be centralized*, which has the effect of establishing a control of quantities, types and sizes of materials. Purchase Orders should be made up in triplicate at least, with copies to Receiving Room and Accounting Department affording the means of checking material received and invoices.

3. *Checking against Purchase Orders of materials received in the Store Room or Yard* as to quantity, condition and quality tends to prevent losses as previously discussed in this paper. All incoming material should be counted and inspected including material returned from jobs and a Material Received Ticket should be made out for all such material. In probably most instances incoming material is checked as to quantity, but an inspection of incoming material as to condition and quality is also of utmost importance. As stated before cracked pipe and fittings not meeting specifications may result in losses through breakage while in service.

4. *Proper Storage of Materials as previously discussed in this paper.*

5. *Proper system of issuing and transferring of materials.* Materials should be issued on requisition of authorized individuals, usually department heads. The General Storekeeper should require the approval of some one in authority on requisitions for the issuance of materials, and materials transferred from one job to another should be handled in the same way. The General Storekeeper must see to it that issued tickets and transferred tickets are made out for all materials issued or transferred without exception in order to enable the materials control system to be complete. It is sometimes hard in a water works business to get Issued Tickets for all materials issued, especially if sub-storerooms are kept in places quite remote from the general storeroom and are not under the jurisdiction of a man who gives his entire time to the storeroom. However, it is up to the General Storekeeper to watch sub-storerooms. Proper system of issuing materials enables proper disposition of charges to be made for

materials issued and transferred and cost records will be more complete and easier to keep.

6. *The taking of physical inventories at frequent intervals.* The taking of physical inventories is an important step in any system of material control. The checking of the physical inventory with the perpetual inventory record is a good barometer of the effectiveness of the system and discloses loop-holes in the steps of the system. Differences that are not warranted, such as differences in large fittings and unreasonable differences in pipe should be checked and reasons ascertained for them. The reasons should be thoroughly investigated to find out which steps in the system are weak or are not being carried out.

Control of materials on repair or service trucks or trailers where it is quite impossible to issue materials for specific jobs due to limited knowledge of materials required, can be covered by stocking trucks or trailers with specific quantities of various materials used. The foreman or driver should be made responsible for the materials and instructed to make out Issued Tickets for materials used, so that at all times each truck or trailer must have on hand its stipulated quantities either in material or Material Issued Tickets. To issue material of this type on memorandum necessitates an additional Stores Record. Keeping stipulated quantities of materials for repairs on Trailers and Trucks does away with a record for materials issued on memorandum.

While the installation of a complete system of material control will cost money, the savings through the system itself are very apt to be reflected in decreased inventories, time saved in handling materials, space saved in storing materials and reduction of losses due to defective materials or materials not meeting specifications.

Materials if not properly controlled constitute a channel through which funds may easily be wasted. I have not touched on dishonesty in this paper. It must be guarded against and the system of issuing material must be tight enough almost entirely to eliminate all possibility of it.

CONTROL TESTS FOR THE TREATMENT OF FEED AND BOILER WATER

By J. K. RUMMEL¹

Coincident with improved methods of treating water for boilers, an effort has been made to provide improved methods of testing which will be sufficiently accurate, and rapid, and, in the hands of power plant operators, be acceptable for regulating the treatments which are recommended. Owing to the different conditions which exist at various plants, it has been difficult to provide single methods for individual determinations which will be acceptable to all. Thus, a number of alternative methods have been adopted. However, it is hoped that through the committees and others who have been doing some work on this problem, many conflicting ideas will be eliminated and more accurate and more generally suitable control tests will be provided. It is also hoped that this discussion of some work on the determination of alkalinity, phosphate and silica will be of assistance to those who are interested in the control of feed and boiler water treatments.

COLLECTION OF SAMPLES

Aside from the methods used for analysis, the method of collecting and handling samples is an important factor in obtaining accurate results. Failure to cool boiler water samples as they are taken, undue exposure of samples to the air and failure to properly remove suspended solids, are all conducive to error.

Permanently installed cooling coils, on boiler sample lines, correct the error due to partial flashing of the sample into steam. Also, they make it easy to take properly cooled samples for control tests.

Clean, well stoppered glass containers prevent contamination of samples by the air during storage.

Except in research work, little attention has been paid to methods of filtering samples to prevent absorption of carbon dioxide from the

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air and the dissolving of suspended solids which are insoluble at boiler temperatures. To overcome this difficulty, Schroeder and Fellows (7) have recommended a copper-screen filter which is placed in the boiler water sample line head of the cooling coil. Thus, the operator can secure a filtered and cooled sample, which will more clearly represent boiler water conditions.

ALKALINITY

Of the many procedures which have been used for the determination of hydroxide and carbonate alkalinity, the most common is that of direct titration of the water sample, with a standard acid, using phenolphthalein and methyl orange indicators. However, it is generally known that a number of possible errors may occur and particular attention has been centered on the tendency to obtain high results for carbonate and total alkalinity when titrating to the methyl end point.

Just how seriously these errors will influence the control of treatments and the results obtained in boilers will depend largely on the kind of treatment used, the nature of the feed water and other conditions at the plant.

In the estimation of sodium hydroxide and sodium carbonate in boiler waters, it has been the writers experience that these titration errors may occur in three principal ways.

1. When the sample contains materials other than sodium hydroxide and sodium carbonate, which add to the acid required to reach the desired titration end points.
2. When the sample is highly buffered, as by high concentrations of sodium phosphate, organic salts, and silicates.
3. When the operator does not see the desired color at the titration end points.

In the first case, corrections for interfering materials may sometimes be applied, as when sodium phosphate is present. Other corrections are more difficult and are seldom possible, particularly in the absence of a complete water analysis. When organic salts interfere, it is sometimes possible to correct most of this error by titrating to a higher pH end point, such as pH 5.

When the sample is highly buffered, changes in the color of the indicator are very gradual and the exact end point becomes indefinite. High concentrations of buffer salts are seldom a necessary part of

the treatment and this condition can usually be avoided. In titrating samples, the use of stronger acids, up to 0.1 N, and the substitution of indicators having a more distinct color change are preferred.

Failure of the operator to see the desired color change may be due to a discolored water sample, or, as is more often the case, lack of training or ability to see the change. When the sample is highly colored, dilution with carbonate-free distilled water permits more accurate titration. The common difficulty of not seeing the desired color at the end point may be remedied by using indicators having a distinct and sharply defined color change.

This information leads to the conclusion that in some cases, when more exact results are required, it will be advisable to substitute other methods, but that in many other cases, especially when suitable indicators are used, direct titration of the sample will give sufficiently accurate results for control work.

With this thought in mind, a number of indicators were considered, including various pairs of indications, such as suggested by Kolthoff and Furman (5). After several trials, attention was directed to the universal type indicators and based on some laboratory work, a Universal indicator was included in the Lab-Rette control testing outfit supplied by The Babcock & Wilcox Company. This indicator, which is similar to that suggested by Kolthoff (6) and others, gives the spectrum colors, starting with red at pH 4 and ending with purple at pH 11. Characteristic colors are shown at intermediate pH values. The advantages of this type of indicator are:

1. A single standardized indicator which is readily available to plant operators.
2. The rapid estimation of the approximate pH value, at the same time and in the same operation as the titration.
3. Sharp, distinct color changes at the titration end points. It is also possible to select the end point, which, for a certain type of water, will agree more nearly with the results obtained by more accurate methods.
4. A visual guide to the progress of the titration, which permits more rapid and less tedious work than with indicators which give little or no warning until the end point is reached.

After approximately five years use by both trained and untrained analysts, it is concluded that this type of indicator is a decided improvement over phenolphthalein and methyl orange, especially for power plant control work.

PROCEDURE

In the recommended procedure, five or more drops of the Universal indicator are added to a 100 ml. sample of water, which is then titrated in the usual manner, with 0.05 N sulphuric acid. The first reading is taken at pH 8, when a distinct green color is shown. The second reading is taken at approximately pH 5, when a decided pink color is shown. The actual ml. of acid used for each part of the titration are recorded under the symbols X and Y. Calculations are then simplified by reference to tables 1 and 2.

While the approximate pH 5 end point is somewhat higher than that for methyl orange, experience with boiler water samples has shown that this higher pH end point gives more reliable results for the carbonate and total alkalinity determinations.

It is concluded that this direct titration procedure can be recommended for a large number of plants, especially when time and facilities are limited, and the treatment requirements do not demand more accurate alkalinity determinations.

PHOSPHATE

The methods for the determination of phosphate, like those for alkalinity, are numerous. They include gravimetric, nephelometric, volumetric and colorimetric procedures. Combinations of these procedures have also been used.

After some investigation, it was concluded that the volumetric and colorimetric methods were most suitable for control work; the other methods being too complicated or inviting too much error to be used in the field.

Volumetric method

In 1927, after a consideration of the various volumetric methods and special procedures, it was decided to use a procedure by which both alkalinity and phosphate could be determined by direct titration of a single sample of boiler water. Except for the titrating acid and indicator, this procedure is like that adopted by Smith (8). This method has met with sufficient success in the testing equipment already mentioned to warrant consideration as a control test for boiler water.

Procedure. In the adopted procedure, alkalinity is first determined by the method already given. Three ml. of 0.05 N sulphuric acid are then added and the sample boiled for two minutes to remove

carbonates. After cooling rapidly to room temperature, the sample is then titrated with 0.05 N sodium hydroxide to pH 8, at which point

TABLE 1

Calculations of alkalinity titrations

Results in parts per million using 0.05 N sulphuric acid

RESULT OF TITRATION	EQUIVALENT SODIUM HYDROXIDE	EQUIVALENT SODIUM CARBONATE	EQUIVALENT SODIUM BICARBONATE
X = O	0	0	(Y) 42
X < Y	0	(X) 53	(Y - X) 42
X = Y	0	(Y) 53	0
X > Y	(X - Y) 20	(Y) 53	0
Y = O	(X) 20	0	0

X = Titration in ml. to pH 8.

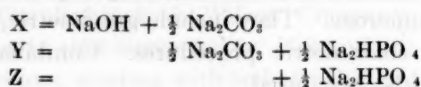
Y = Titration in ml. from pH 8 to pH 5 (approx.).

(X + Y) 26.5 = p.p.m. of total alkalinity as equivalent sodium carbonate.

To express results in terms of hydroxide, carbonate and bicarbonate, the following factors are used: OH 8.5, CO₃ 30, HCO₃, 30.5.

TABLE 2

Calculation of alkalinity and phosphate titrations using 0.05 N sulphuric acid and 0.05 N sodium hydroxide



Substituting the ml. of sulphuric acid or sodium hydroxide for the symbols X, Y and Z:

Parts per million

(X + Z - Y) 20 = Sodium Hydroxide, NaOH
(Y - Z) 53 = Sodium Carbonate, Na₂CO₃
(Z) 71 = Disodium Phosphate, Na₂HPO₄
(X + Y - Z) 26.5 = Total Sodium Hydroxide and Carbonate Alkalinity as Equivalent Sodium Carbonate.

To express results in terms of hydroxide, carbonate and phosphate, the following factors are used: OH 8.5, CO₃ 30, PO₄ 47.5.

X = Titration in ml. to pH 8.

Y = Titration in ml. from pH 8 to pH 5.

Z = Titration in ml. from pH 5 to pH 8.

the green color of the Universal indicator is again developed. After deducting the 3 ml. of sodium hydroxide required to neutralize the 3 ml. of acid, the balance of the 0.05 N sodium hydroxide used is

recorded under the symbol Z. The alkalinity and phosphate values, in terms of sodium hydroxide, sodium carbonate, total alkalinity as equivalent sodium carbonate, and sodium phosphate are then calculated in accordance with table 2.

It is assumed that the phosphate in the hot alkaline boiler water takes the form of disodium phosphate. This seems to be the safest procedure in estimating the recommended A. S. M. E. Code ratio of sodium sulphate to total alkalinity, as sodium hydroxide and sodium carbonate calculated to equivalent sodium carbonate, for inhibiting caustic embrittlement.

In a previous investigation, it was found that if phenolphthalein and methyl orange are used for indicators, both the alkalinity and phosphate results will often be too high. By substituting for methyl orange, a mixture of equal parts 0.1 per cent methyl orange and 1.0 percent methyl red, the results were practically the same as when Universal indicator was used. It is, therefore, important that the acid end point be set at approximately pH 5 and not at some lower value.

Table 3 gives some data which have been obtained for the equivalent disodium phosphate content, as determined by gravimetric and volumetric means, for boiler waters from different locations in the United States. This information indicates that unless a high degree of accuracy is required, the adopted volumetric method should give results by which boiler water treatment can be satisfactorily controlled.

Colorimetric methods

Following this application of the alkalinity and phosphate volumetric method, the more direct control methods were investigated. Of these, certain colorimetric methods, which have been developed in the field of biological chemistry, are of special interest. In these methods an acid solution of ammonium molybdate is added to the sample, producing phosphomolybdic acid, which, when reduced by certain chemicals, produces a blue color. This blue color increases in intensity with the concentration of phosphate originally present in the sample; thus, when comparisons are made with suitable standards, quantitative results are obtained.

The reducing agents which have been used in these analyses are—hydroquinone, stannous chloride and 1, 2, 4 aminonaphtholsulphonic acid. Straub (9) has modified the Bell and Doisy (1) procedure in

which hydroquinone is used as a reducing agent and applied it to boiler water analyses with considerable success. Other modifications have also been recommended. Faber and Youngburg (3) have recently suggested a modified method in which stannous chloride is

TABLE 3

Volumetric and gravimetric determinations of sodium phosphate in boiler waters
Results in parts per million

	SODIUM PHOSPHATE (Na_2HPO_4)			SILICA (SiO_2)	TOTAL SOLIDS
	Gravimetric	Volumetric	Difference		
1	4	11	+7	209	2,338
2	6	5	-1	124	1,168
3	9	14	+5	109	1,460
4	10	14	+4	186	1,932
5	13	21	+8	117	1,012
6	24	25	+1	213	2,294
7	25	20	-5	150	1,486
8	34	42	+8		1,895
9	49	46	-3	25	179
10	81	78	-3	12	256
11	83	75	-8	42	1,036
12	84	84	0	71	1,585
13	92	73	-19	131	1,421
14	98	91	-7	202	2,236
15	99	87	-12	172	1,979
16	107	83	-14	173	
17	111	78	-33	95	1,376
18	113	114	+1		
19	116	142	+26	53	1,550
20	124	135	+11		1,184
21	135	135	0	70	1,644
22	137	135	-2		
23	145	121	-24	68	686
24	161	142	-19	73	
25	388	382	-6		

the reducing agent. However, it is reported that this method will give very dark colors for the usual quantity of phosphate found in boiler water. Fiske and Subbarow (4) have tried a large number of organic reducing agents and according to their findings, 1, 2, 4-aminonaphtholsulphonic acid is the most suitable. Their procedure is also much simpler than that in which hydroquinone is used, since it requires only two principal reagents, and very little change was

necessary to make it applicable to boiler water control analyses. Accordingly, considerable time was spent in investigating this procedure. At the same time, some comparisons were made with the procedure using hydroquinone.

It was concluded that the aminonaphtholsulphonic acid procedure is preferable to the hydroquinone procedure in ease and time of operation, influence of interfering substances in the sample, and in accuracy and general reliability of results. However, it may also be concluded that the hydroquinone method is not unsuitable for this work, particularly if exact results are not required.

Rate of color development

Using a Campbell-Hurley type colorimeter to make color comparisons with fixed color standards, the rate at which the blue color is developed in mixtures of distilled water and sodium phosphate was determined. The color standards were made from mixtures of inorganic salt solutions.

In both of the colorimetric methods tried, most of the blue color is developed in the first five minutes after adding the reagents. However, with aminonaphtholsulphonic acid the color intensity after this five minute period is usually more stable for the ensuing hours than is the case with hydroquinone. That is, with aminonaphtholsulphonic acid the color intensity remains practically constant for one hour, while with hydroquinone a further increase in color intensity may take place during this time. For example, when 1 ml. of 10 N sulphuric acid was added prior to the usual reagents, the hydroquinone color increased at a rapid rate for the first hour, while no color increase was indicated until after the first 15 minutes with aminonaphtholsulphonic acid. Since it is sometimes desirable to use more acid, this is an important point in favor of the adopted method.

Some of the data are illustrated in figure 1.

It is concluded that errors due to variations in color intensity should be less with the aminonaphtholsulphonic acid method.

Interfering materials

In the analysis of boiler waters, some of the materials which may interfere with the normal development of the blue color due to phosphates are—sulphates, chlorides, nitrates, organic matter and sili-

cates. Also, coloring matter may sometimes make colorimetric analyses difficult.

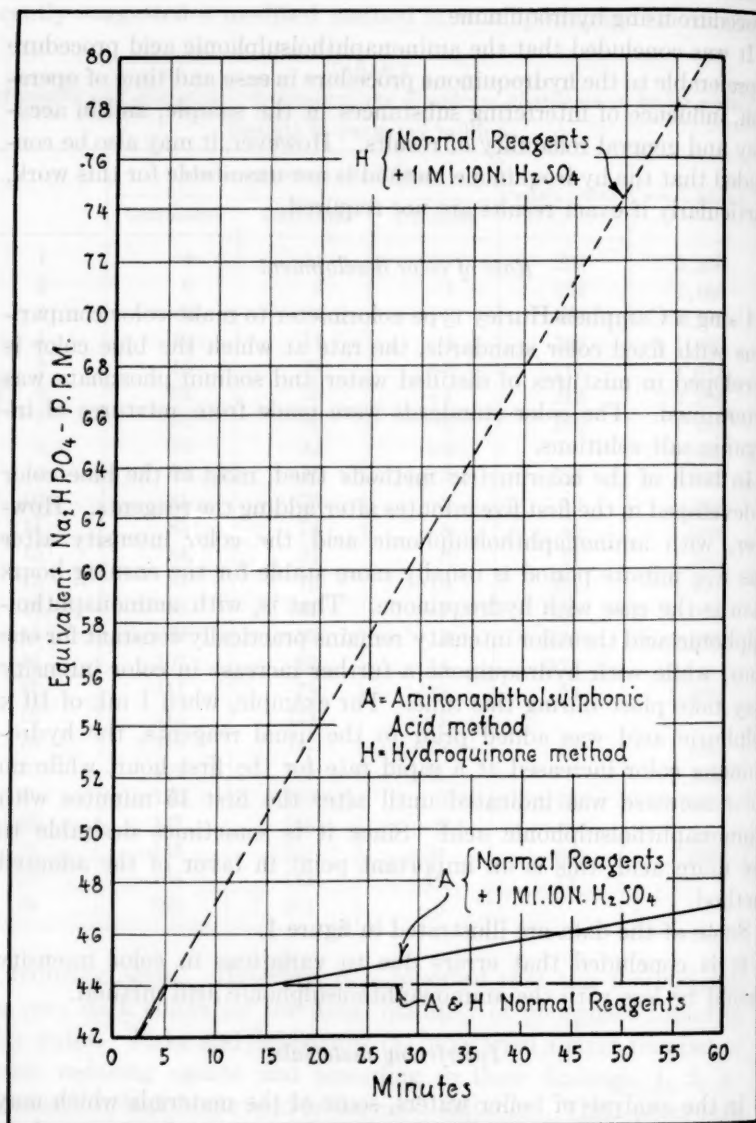


FIG. 1. EFFECT OF TIME AND ACIDITY ON COLOR DEVELOPMENT WITH 44 P.P.M. Na_2HPO_4 IN DISTILLED WATER

Sulphates, chlorides, nitrates, and certain organic matter cause decided fading of the color which is developed with hydroquinone, whereas, with the exception of certain organic matter, they have no noticeable effect on the color developed with aminonaphtholsulphonic

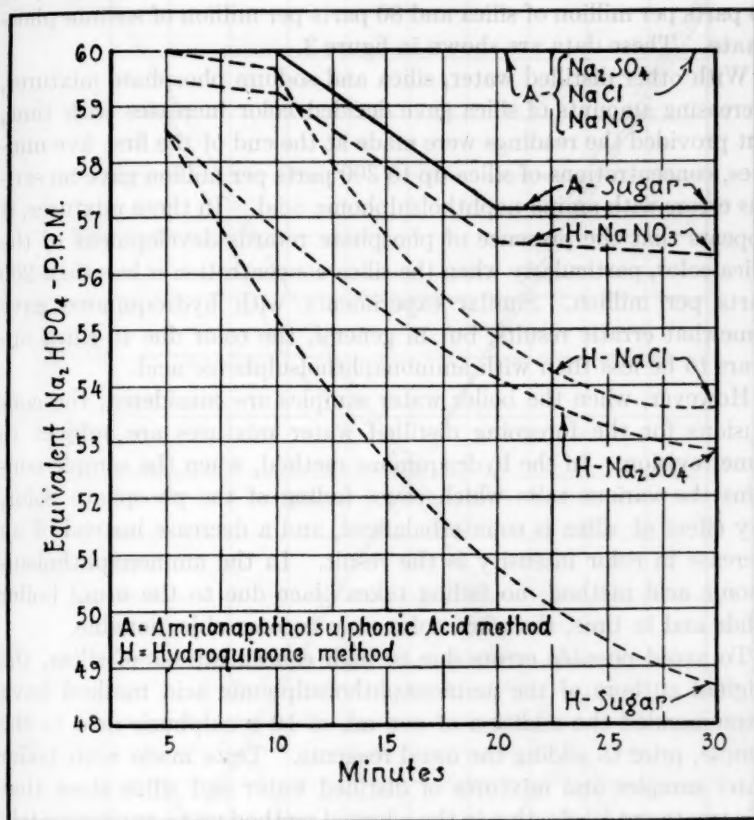


FIG. 2. EFFECT OF INTERFERING MATERIALS; 1000 P.P.M. EACH WITH 60 P.P.M. Na_2HPO_4 IN DISTILLED WATER

acid. The data for 1000 parts per million each of these materials are illustrated in figure 2.

Silicates produce blue or bluish green colors with the reagents, and these colors increase in intensity with silicate concentration and time. The bluish green silica color is developed with hydroquinone. Experiments with silica alone in distilled water have shown that with

aminonaphtholsulphonic acid the effect of silica is about the same in the first five minutes as with hydroquinone. During longer periods, the colors become more intense with aminonaphtholsulphonic acid.

With mixtures of both phosphate and silica in distilled water, both methods give satisfactory results with varying concentrations up to 50 parts per million of silica and 80 parts per million of sodium phosphate. These data are shown in figure 3.

With other distilled water, silica and sodium phosphate mixtures, increasing amounts of silica gave decided color increases with time, but provided the readings were made at the end of the first five minutes, concentrations of silica up to 300 parts per million gave no serious errors with amino-naphtholsulphonic acid. In these mixtures, it appears that the presence of phosphate retards development of the silica color, particularly when the silica concentration is less than 200 parts per million. Similar experiments with hydroquinone gave somewhat erratic results, but in general, the color due to silica appears to be less than with aminonaphtholsulphonic acid.

However, when the boiler water samples are considered, the conclusions for the foregoing distilled water mixtures are subject to some revision. In the hydroquinone method, when the sample contains the various salts which cause fading of the phosphate color, any effect of silica is counterbalanced, and a decrease instead of an increase in color intensity is the result. In the aminonaphtholsulphonic acid method, no fading takes place due to the usual boiler solids and in time, the silica color may become objectionable.

To avoid possible errors due to high concentrations of silica, the original authors of the aminonaphtholsulphonic acid method have recommended the addition of one ml. of 10 N sulphuric acid to the sample, prior to adding the usual reagents. Tests made with boiler water samples and mixtures of distilled water and silica show that this treatment is effective in the adopted method up to approximately 500 parts per million of silica. Since large additions of acid may greatly retard the development of the color due to phosphates, such additions are not recommended.

Figure 4 and table 4 give some of the experimental data for the effect of time and silica concentrations on the rate at which color intensity will be developed. This and other information lead to a conclusion that considerable error may be avoided, if samples and standards are compared immediately after the five minute reaction period following the addition of the reagents.

Samples which are highly alkaline may influence the pH value of the final mixture of sample and reagents, and with it, the rate of

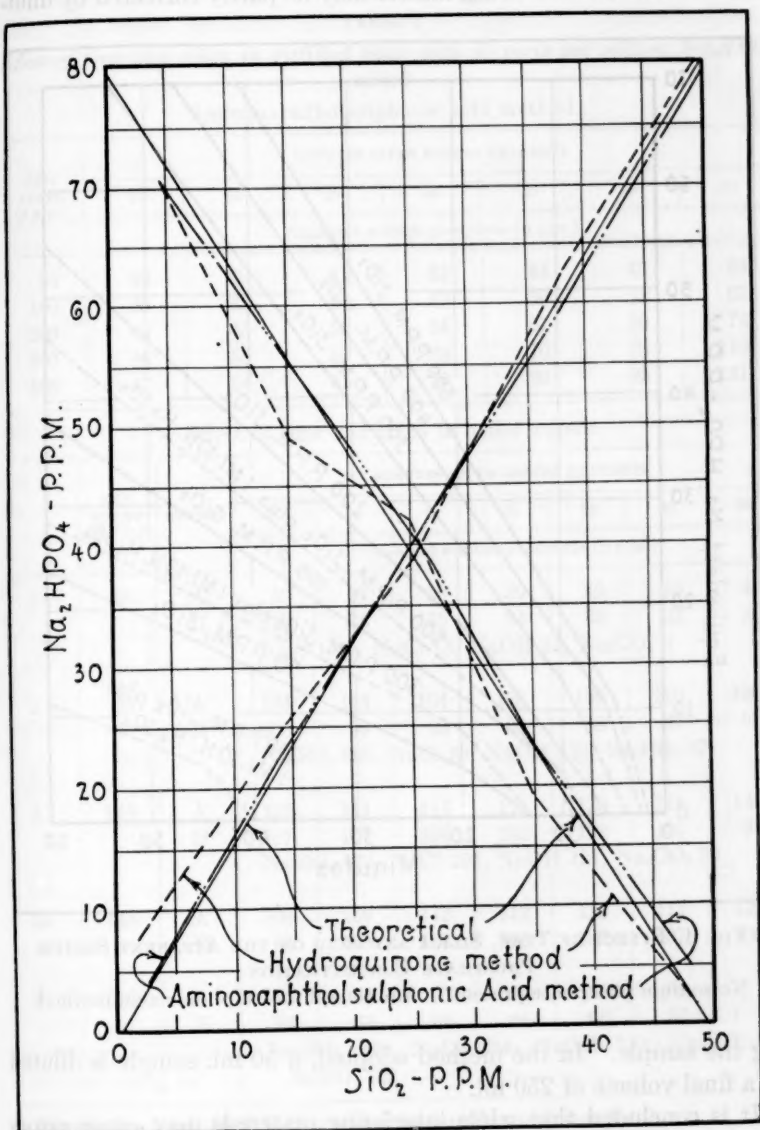


FIG. 3. EFFECT OF VARYING CONCENTRATIONS OF SILICA AND SODIUM PHOSPHATE IN DISTILLED WATER

color development. This can be avoided by adding sufficient sulphuric acid to neutralize the measured sample.

The error due to coloring matter may be partly corrected by dilut-

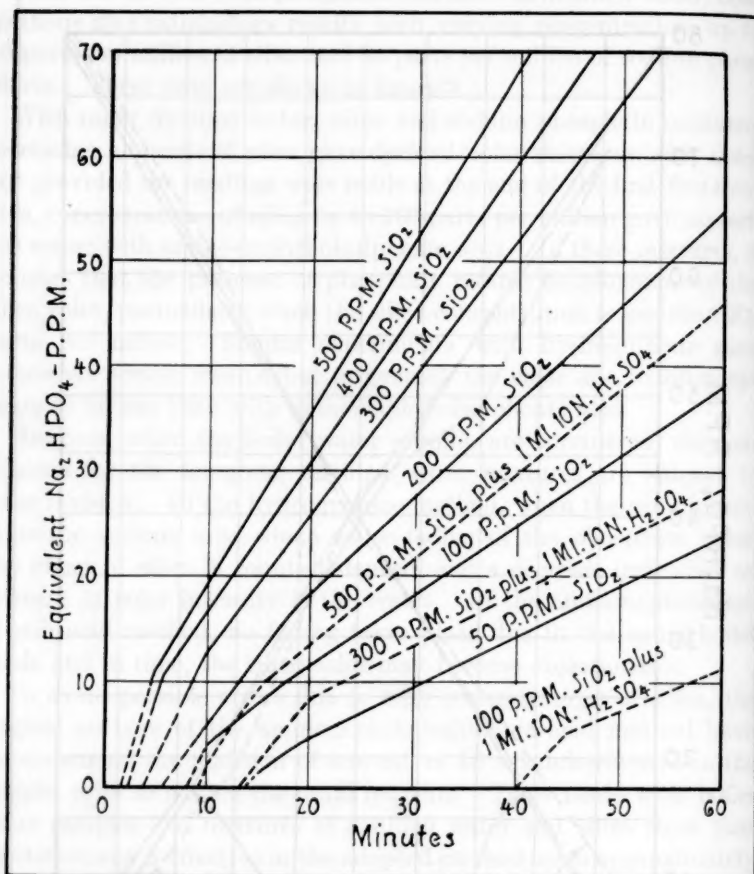


FIG. 4. EFFECT OF TIME, SILICA AND ACID ON THE APPARENT SODIUM PHOSPHATE CONCENTRATION

No sodium phosphate present. Aminonaphtholsulphonic acid method

ing the sample. In the method adopted, a 50 ml. sample is diluted to a final volume of 250 ml.

It is concluded that while interfering materials may cause errors in both of the colorimetric methods tried, the aminonaphtholsulphonic acid method is influenced the least.

To test the suitability of the adopted aminonaphtholsulphonic acid control method, a number of boiler water samples, from power

TABLE 4

Effect of time and silica in distilled water with 40 parts per million Na_2HPO_4 added

Aminonaphtholsulphonic acid method

SiO ₂ ADDED (P.P.M.)	MINUTES AFTER ADDING REAGENTS						
	5	10	15	20	25	30	60
	Apparent sodium phosphate (p.p.m.)						
50	40	40	41	43	44	45	53
100	40	43	45	47	50	52	67
200	42	45	50	54	57	59	78
400	46	55	60	65	70	76	116
800	47	54	63	70	80	89	131

Effect of time and silica in boiler waters

	SiO ₂ FOUND (P.P.M.)	METHOD	MINUTES AFTER ADDING REAGENTS						
			5	10	15	20	25	30	60
			Apparent sodium phosphate (p.p.m.)						
1	25	A	36	37	39	39	39	40	43
		H	37	35	35	34	33	32	25
			Na_2SO_4 67, NaCl 13, NaOH 22, Na_2CO_3 0						
2	90	A	104	104	104	108	109	110	120
		H	100	99	99	99	98	97	90
			Na_2SO_4 859, NaCl 58, NaOH 123, Na_2CO_3 87						
3	148	A	106	111	114	116	120	121	140
		H	107	107	104	102	102	100	91
			Na_2SO_4 672, NaCl 294, NaOH 171, Na_2CO_3 30						
3a	148	A	106	109	112	112	113	114	121
		H	99	103	103	106	107	107	106
4	500	A	75	75	77	79	82	88	
		H	65	65	62	61	60	58	
			Na_2SO_4 , 732, NaCl 264, NaOH 152, Na_2CO_3 82, NaNO_3 122						

Sample 3a, 1 ml. 10 N H_2SO_4 added to samples and standards.

Sample 4, synthetic boiler water.

A, aminonaphtholsulphonic acid method; H, hydroquinone method.

plants using sodium phosphate treatment, were analyzed by the adopted colorimetric, gravimetric and volumetric methods. The data, which are given in table 5, demonstrate that with these varying concentrations of phosphates and other dissolved solids in boiler waters, satisfactory results may be obtained by the adopted control

TABLE 5

Comparison of colorimetric, gravimetric and volumetric sodium phosphate determinations of boiler water

	SODIUM PHOSPHATE (Na_2HPO_4)			SILICA (SiO_2)		PARTS PER MILLION					ORGANIC MATTER	TOTAL SOLIDS
	Colorimetric	Gravimetric	Volumetric	Colorimetric	Gravimetric	NaOH	Na_2CO_3	Na_2SO_4	NaCl	Fe_2O_3		
1	36	34	43		56	496	59	775	183		281	1,895
2	42	50	46	25	25	22		67	13	2		179
3	72	82	78	10	12	23	8	119	10	2		256
4	70	83	75	42	42	143	29	688	10	10	31	1,036
5	85	84	84	75	71	167	22	931	188	6	116	1,585
6	88	91	99	35	39	20	26	443	59	2	8	688
7	89	102	89	40	56	121	40	762	12	15	76	1,184
8*	110	107	121			60	32	696	175			1,126
9	103	111	78	90	95	123	87	859	58	27	18	1,378
10	114	116	142	148	153	171	30	672	294	11	103	1,550
11*	126	124	135			74	16	735	181			1,184
12	132	135	135	75	70	158	11	946	194	6	124	1,644
13*	128	136	135			35	23	488	89			823
14	133	145	121	55	68	77	30	320	18	19	9	686
15	151	161	142	65	73	77	23	316	18	20		688
16	317	307	344	65	48	122	15	1,590	158	4	102	2,346

* Partial analysis of sample.

Fe_2O_3 —iron oxide and alumina.

methods. The aminonaphtholsulphonic acid colorimetric method is the most reliable.

The hydroquinone method was the same as that adopted by Straub, except that a colorimeter was used for making comparisons with standards.

The aminonaphtholsulphonic acid method is given as follows:

AMINONAPHTHOLSULPHONIC ACID METHOD

Reagents

Molybdate-acid solution. Dissolve 5 grams of ammonium molybdate, $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$, in 40 ml. of distilled water and add to a 200 ml. flask containing 100 ml. of 10 N Sulphuric acid. Make up to 200 ml. volume with distilled water.

The 10 N sulphuric acid is made by adding 278 ml. of concentrated sulphuric acid (specific gravity 1.84) to approximately 500 ml. of distilled water and diluting the mixture to one liter with distilled water.

1, 2, 4 aminonaphtholsulphonic acid solution. Dissolve 0.5 gram of this chemical (Eastman Kodak No. 360) in 5 ml. of 20 percent sodium sulphite solution and dilute to 200 ml. with 15 percent sodium bisulphite solution. If precipitation then occurs, add just sufficient 20 percent sodium sulphite to redissolve. Store in a brown bottle which is kept well stoppered when not in use. Make a fresh solution every two weeks.

The 20 per cent sodium sulphite solution is made by dissolving 10 grams of sodium sulphite, $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$, in 19 ml. of distilled water.

The 15 percent sodium bisulphite solution is made by dissolving 30 grams of the salt in 200 ml. of distilled water. Filter after standing for sufficient time to give a clear filtrate.

Standard phosphate solution. Dissolve 0.2865 gram of pure thoroughly dried monopotassium phosphate, KH_2PO_4 , in one liter of distilled water containing 10 ml. of 10 N sulphuric acid. One ml. of this solution in 50 ml. of water is equivalent to 4 parts per million of PO_4 .

By the same procedure, 0.1917 gram of monopotassium phosphate in one liter gives a standard solution, one ml. of which in 50 ml. of water is equivalent to 4 parts per million of Na_2HPO_4 .

Procedure

To 50 ml. of filtered water sample, which has been cooled to room temperature, add 10 ml. of molybdate acid solution. To this mixture add 4 ml. of aminonaphtholsulphonic acid solution. Mix, dilute to 250 ml. volume with distilled water and mix again.

In five minutes, compare the color developed in the sample with colors developed in standards which are made up at the same time, from the standard phosphate solution which has been diluted to 50 ml. volume, treated with the same two reagents as in the sample, and finally diluted to 250 ml. volume with distilled water.

In case the silica concentration of the sample is known to be high, 1 ml. of 10 N sulphuric acid should be added to the 50 ml. sample and the standard. If the alkalinity of the sample is high, say over 600 parts per million, this should be neutralized with the sulphuric acid, using litmus paper or phenolphthalein as indicators.

Color comparisons with known standards may be made in several ways. Approximate results may be obtained with Nessler tubes, or more accurate results can be obtained by the use of colorimeters. If Nessler tubes are used, one tube is filled to a suitable height with the sample, and the standard solution

added to a second tube until the two colors match in intensity when looking down through the tubes. The calculation is then made as follows:

$$\frac{\text{p.p.m. in standard} \times \text{mm. height of standard}}{\text{mm. height of sample}} = \text{p.p.m. in sample}$$

The results may be expressed in terms of PO_4 or Na_2HPO_4 depending on the standard used.

If the colorimeter is used, a similar procedure is followed, except that the liquid heights are varied by other means. The calculation is the same.

Depending on the concentration of phosphate in the sample, other dilutions than 50 ml. of sample in 250 ml. of total volume may be desirable. For example, if the equivalent disodium phosphate is in excess of 75 parts per million, or the phosphate (PO_4) in excess of 50 parts per million, a smaller sample should be used; or, if the phosphate content is so low as to give very little color, a larger sample should be used. Also, as a matter of convenience or preference other combinations such as 50 ml. of sample and 100 ml. total volume may be desirable. The same amounts of reagents should be used as in the adopted method. It will be necessary to adjust standards according to the amount of sample used.

SILICA

Due to the importance of silica in feed and boiler water, as a prevalent cause for objectionable deposits in boiler and superheater tubes and steam turbines, it has been necessary to investigate and adopt a rapid procedure for estimating silica which will be useful for control purposes.

Considerable interest was taken in the colorimetric method for dissolved silica, which was proposed by Dienert and Wandenburgke (2) and later modified by Thayer (10) to eliminate errors due to iron and phosphates. Due to the possibility of considerable colloidal silica also being present, some initial interest was taken in Dienert and Wandenburgke's modified method by which it is claimed that colloidal silica is dissolved by boiling the sample with sodium bicarbonate. In these methods a yellow color, which increases in intensity with silica concentration, is developed when the silica reacts with the acid solution of ammonium molybdate.

It has been concluded that the adopted procedure as recommended by Thayer (10) is satisfactory for control work. However, this method is somewhat long and when iron and phosphates are not present in sufficient quantity to interfere, it becomes much shorter, involving the use of only two of the six reagents.

Experiments made with a Duboseq type colorimeter and Nessler

tubes indicate that within the limits which are recommended, the increase in intensity of the yellow color is directly proportional to the silica content of the sample. Also, that essentially all the yellow color is developed in the first ten minutes after adding the reagents.

Tests made to determine the best way to compare the colors developed in the samples with liquid color standards indicate that by looking down through Nessler tubes in the low concentrations and through the sides of the tubes in the higher concentrations, the best results will be obtained. Using 50 mm. tall form Nessler tubes, it is possible to estimate within one part per million up to 5 parts per million of silica and within 5 parts per million at the upper concentration limit of 50 parts per million of silica. It is, therefore, recommended that for accurate work the samples be diluted to below 30 parts per million of silica. Due to the low color intensity developed by the silica and ammonium molybdate, the method is not suitable for strongly colored samples.

To determine the possible effect of interfering materials and to test the general accuracy of the method, a number of feed and boiler water samples were analyzed by the colorimetric and gravimetric procedures. The samples were first filtered to remove suspended solids. The results, which are shown in table 6, indicate that in most samples the total silica as determined by the gravimetric method agrees rather closely with that found by the colorimetric method. If greater accuracy is desired, this may be made possible by close regulation of pH values at the various steps in the procedure and by preliminary neutralization of highly alkaline boiler water samples. Assuming that the colorimetric method determines only dissolved silica, it is apparent that, in most boiler waters, colloidal silica is not a large part of the total. Thus, it may be further assumed that most of the silica is present as silicates, and in some cases, it may account for high carbonate values as found by titration.

Following Dienert and Wandenbulcke's recommendation, some of the few samples, which contained silica in considerable excess of that found by the colorimetric method, were first boiled with 0.4 per cent sodium bicarbonate in a platinum dish and the colorimetric determination repeated. This method gave only a slight increase in the total silica found and did not account for most of the difference between the colorimetric and gravimetric results. Preliminary boiling with 0.4 per cent sodium hydroxide was then tried, but instead of

TABLE 6

Comparison of colorimetric and gravimetric silica determinations of feed and boiler waters

Feed water

SILICA (SiO ₂)			PARTS PER MILLION							ORGANIC MATTER	SUSPENDED SOLIDS	TOTAL SOLIDS
Colorimetric	Gravimetric		Ca(HCO ₃) ₂	CaSO ₄	Mg(HCO ₃) ₂	NaHCO ₃	Na ₂ SO ₄	NaCl	R ₂ O ₃			
1	2	1	35*	104	27*		68	71	2	37	78	423
2	6	5		50	21		8		1	15		100
3	11	10	3	116	65		14	17	1	24		250
4	17	17	18		8	6	1	7	4	4		65
5	21	21	53		35	258		112	1	9		489
6	48	48	60	1	42		10	7	11	19		198
7	47	48	27		45	36	9	50	1	7		232
8	50	51	24*	97			36	112	2	84		406

Boiler water

	SILICA (SiO ₂)		PARTS PER MILLION							ORGANIC MATTER	SUSPENDED SOLIDS	TOTAL SOLIDS
	Colorimetric	Gravimetric	NaOH	Na ₂ CO ₃	Na ₂ SO ₄	NaCl	Na ₂ HPO ₄	R ₂ O ₃				
1	10	12	23	8	119	10	82	2				256
2	25	25	22		67	13	50	2				179
3	35	39	20	26	443	59	91	2	8			688
4	42	42	143	29	688	10	83	10	31			1,036
5	65	48	122	15	1,590	158	307	4	102			2,346
6	48	52	272	201	130	23		8	481		833	2,000
7	48	54	88	81	390	1,101		4	126			1,844
8	40	56	121	40	762	12	102	15	76			1,184
9	62	67	174	75	1,084	298	46	4	87		23	1,858
10	55	68	77	30	320	18	145	19	9			686
11	65	73	77	23	316	18	161	20				688
12	75	70	158	11	946	194	135	6	124			1,644
13	75	71	167	22	931	188	84	6	116			1,585
14	90	95	123	87	859	58	111	27	18			1,378
15	148	153	171	30	672	294	116	11	103			1,550
16	130	182	889	667	207	494	23	355	574		68	3,459
17	2,350	2,350	1,964	658	1,026	336		30	711		67	7,142

* Actually found as carbonates.

R₂O₃—iron oxide and alumina.

increasing, the colorimetric value was decidedly decreased. The cause for this action has not been fully investigated.

The adopted colorimetric procedure is as follows:

METHOD

Reagents

Acetic acid. Dilute 10 ml. of glacial acetic acid to 100 ml. with distilled water.

Sodium phosphate. Dissolve 25.2 grams of sodium phosphate, $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$, in distilled water and dilute to one liter.

Calcium chloride. Dissolve 10 grams of anhydrous calcium chloride in 90 ml. of distilled water. Filter.

Ammonium hydroxide. Dilute 35 ml. of concentrated ammonium hydroxide (specific gravity 0.90) to 200 ml. with distilled water.

Sulphuric acid 1:1. Add carefully 100 ml. of concentrated sulphuric acid (specific gravity 1.84) to 100 ml. of distilled water.

Ammonium molybdate. Dissolve 10 grams to ammonium molybdate, $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$, in 100 ml. of distilled water.

Picric acid standard. Dissolve 25.6 milligrams of C.P. dry picric acid in distilled water and dilute to one liter. 0.4 ml. of this solution, diluted to 50 ml., is equivalent to one part per million of silica by the method as given. (Check this standard against a solution of known silica content, such as can be made from sodium silicate.)

Procedure

To a 250 ml. beaker add 100 ml. of filtered sample, 2 ml. acetic acid solution and 3 ml. of sodium phosphate solution. (If the sample contains more than 100 parts per million of iron, more phosphate solution is needed.) Heat the mixture just to the boiling point to coagulate the precipitate formed, filter, wash with distilled water, and cool filtrate to room temperature. To precipitate the remaining sodium phosphate, add 2 ml. of calcium chloride and make alkaline with 2 ml. of ammonium hydroxide solution. Stir the mixture and let stand for 10 to 20 minutes before filtering off the calcium phosphate. Wash the filter with distilled water and add the washings to the filtrate.

To the filtrate contained in a 200 ml. volumetric flask, add 2 ml. of ammonium molybdate and 0.5 ml. of sulphuric acid—1:1 (or sufficient to give a pH value of approximately 1.5). Mix, and after about ten minutes, make up to 250 ml. volume with silica-free distilled water. A blank determination should be made with the distilled water and a correction applied if required.

The sample is then compared to picric acid or other standard solutions in Nessler tubes. If desired, graduated tubes may be used and the silica concentration calculated from readings obtained when the standard and the sample match in color. Approximate results may be obtained by making up a series of color standards from 5 to 30 parts per million, which will compare with the 50 ml. of sample in the Nessler tube.

If the sample contains more than 30 parts per million of silica, use less than 100 ml. of sample and multiply the result by 100 over the ml. of sample used.

If the sample is known to contain no phosphate and less than 10 parts per million of iron, the first part of this procedure may be omitted. That is, only the ammonium molybdate and sulphuric acid reagents are required.

Other color standards may be substituted for picric acid. Colored glasses or solutions of inorganic salts are sometimes used. The picric acid standards fade slowly and they should be kept out of the light and renewed monthly, or as often as perceptible fading takes place. Freshly prepared sodium silicate solution may also be used for developing color standards.

ACKNOWLEDGMENTS

The author is indebted to J. B. McIlroy and C. O. Lowe of The Babcock and Wilcox Company's Laboratory for a considerable part of the analytical work which has been shown.

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SOCIETY AFFAIRS

THE ANNUAL CONVENTION

The Fifty-second Annual Meeting of the American Water Works Association was held at Memphis, Tenn., from May 2 to 5, 1932. An excellent program was presented and a very complete and attractive array of exhibits was provided. About 375 active members registered, with a total registration of over 700.

Monday Morning Session. The session was called to order by President Ross L. Dobbin, and after an address of welcome by Mayor Watkins Overton of Memphis, President Dobbin reviewed the progress of the Association during the past year.

He reported visiting a number of the sections in session throughout the country, and found all in flourishing condition, with enthusiasm displayed to a marked degree. Papers presented at the various sections were uniformly good. He expressed the belief that the smaller meetings are fully as important as the large ones, but that some difficulty is being encountered in certain instances in securing speakers. He suggested that the national Association assist the smaller sectional organizations in overcoming this difficulty.

Among the accomplishments of the past year President Dobbin cited the progress of the Water Works Practice Committee under the direction of Malcolm Pirnie; the retention of Abel Wolman as Editor of the JOURNAL; the work of the Committee on Water Works Betterments to afford unemployment relief, under the direction of H. P. Eddy; activities of the Economic Committee on Water Works Personnel, under the direction of W. W. Brush, Chairman. Mr. Dobbin found very little disposition on the part of municipal officials to curtail water works maintenance, but marked reduction of capital expenditures was noted. He emphasized that now is the time to bring the water works plant up-to-date, by relaying services, extending mains, removing dead ends, etc.

In concluding, President Dobbin praised the work done by the Secretary and his staff, as well as the several committees which are at present engaged in Association work.

The unanimous election of George W. Pracy, Superintendent, San Francisco Water Department, nominee for President, and Wm. W. Brush, Chief Engineer, Department of Water Supply Gas and Electricity, New York, nominee for reelection as Treasurer, was declared, no other candidates having been named.

Awards

Malcolm Pirnie, Chairman of the Diven Memorial Award Committee, announced the award of the Diven memorial medal to Wm. W. Brush, the Treasurer of the Association. This medal is presented each year to the member who has done the most outstanding work for the Association.

In accepting the medal, Mr. Brush eulogized John M. Diven, who served so many years as Secretary of the Association, and commended the usefulness, devotion and generous service of Mr. Diven.

Mr. Norman J. Howard, Chairman of the Committee on the John M. Goodell award for the best contribution to the water works field during the past year, announced the recipient of the award as John R. Baylis, Physical Chemist, Bureau of Engineering of Chicago, Ill., for his "introduction of activated carbon for taste and odor removal."

Secretary's report

The report of the Secretary showed an excess of income over expenditures of \$5,000 for the year 1931 over 1930. The excess for 1930 over 1929, was \$2,400. The promise for the current year is not quite so bright. From January 1, 1932, to May 1, 65 members were added and 120 dropped. Despite the drop in membership during the first four months of the year, and any drop which may take place during the balance of the year, it is assured that the Association will be able to keep within its budget.

Treasurer's report

Treasurer Wm. W. Brush reported the financial condition of the Association as satisfactory, considering the present business depression. The budget for 1932 has been set at \$69,750, which is well within the estimated income for the year.

Report of Water Works Betterment Committee

A report on work of the Immediate Water Works Betterment Committee, of which Harrison P. Eddy is Chairman, was presented

by E. Sherman Chase, representing Mr. Eddy. The report indicated that water works improvement and extensions estimated to cost \$550,000,000, were needed at this time, but due to difficulties in municipal financing, this work was definitely delayed. Members of the Committee had appeared both before the Congressional and Senate Committees, but little encouragement was received insofar as Federal help in financing the work is concerned. The Committee then endeavored to locate private sources of revenue for such purpose, but with little success. The committee urged that water works men bring the matter before their respective city officials in order to develop interest and action on the program in this manner. Following the report of the committee, Malcolm Pirnie reviewed the status of the water works field.

A motion was made by Mr. Pirnie recommending action on the part of water works men to interest officials in water works betterment.

In seconding the motion, Dennis F. O'Brien, Director of the Association, complimented Mr. Pirnie on his work, and pointed out that water was a commodity, and hence investments in water works improvements should not be considered as a tax.

Mr. Willard T. Chevalier also discussed water works improvements and pointed out the confusion commonly encountered among city officials in regard to capital investments and cost of municipal government.

Mr. S. B. Morris, Chief Engineer, Water Department, Pasadena, Cal., called attention to the fact that even if the cost of money were on the basis of $7\frac{1}{2}$ percent for bond issues covering 20 to 30 years, there would still be a saving in cost of doing work at the present time of approximately 20 percent.

Mr. Pirnie's motion was at this time put to vote and carried unanimously.

Monday Afternoon Session. The first paper on Monday afternoon's program was "Use of Plain End Pipe and Specials as Against Bell and Spigot Pipe and Solid Sleeves," by T. J. Skinker, Engineer, St. Louis Water Department, St. Louis, Mo. The paper was discussed by A. F. Porzelius, T. A. Leisen, H. P. Boncher and A. S. Hibbs.

The use of non-ferrous service pipe was discussed by George W. Pracy, James E. Gibson, A. F. Porzelius, S. B. Morris, A. S. Hibbs, F. G. Smith and T. A. Leisen.

Mr. J. E. Gibson, Manager and Engineer, Commissioners of

Public Works, Charleston, S. C., presented a paper on "Need of Coöperation Between Architects, Plumbers and Water Departments." It was discussed by T. A. Leisen, L. N. Thompson, T. H. Wiggin and E. O. Sweet.

The sterilizing of new mains and mains contaminated by repair work in New York City, was discussed by William W. Brush, Robert Spurr Weston, H. W. Griswold and others.

In discussing the subject of "Shut Offs for Non-Payment of Water Bills During the Present Depression," W. Z. Smith, General Manager, Water Works, Atlanta, Ga., pointed out that the question presents a most difficult problem to all Superintendents. It was further discussed by A. F. Porzelius, C. H. Grinnell, Patrick Gear, Wm. W. Brush and T. J. Skinner.

Mr. F. E. Hall, Superintendent of Water Works, Greenville, Miss. in his paper on "Emergency Protection of Water Works in Flooded Areas," described the Mississippi flood of 1927, its effect upon the operation of the Greenville Water Works System, and the ways in which these obstacles were at least partially overcome.

That it is advisable to mark fire plugs in such a manner as to indicate the quantity of water available, as well as other characteristics, was held by Thomas L. Amiss, Superintendent of Water and Sewerage, Shreveport, La. E. O. Sweet read a letter from the Maine Utilities Association which recommended that a National code for marking fire hydrants be established, said marks to indicate the capacity of a hydrant. C. W. Mowry, Fire Protection Engineer, Boston, Mass. believed that the move would be a very helpful one in preventing the practice of hooking too many engines to a single hydrant, such as is sometimes done when outside aid responds to a fire. Robert C. Dennett of the National Board of Fire Underwriters also expressed the opinion that the subject is of considerable importance in small cities. He suggested as an alternate marking on the hydrants the size of the mains to which they are connected.

Tuesday Morning Session. The first paper on the Tuesday Morning Session was devoted to "Turbine Well Pumps—their History and Development," by David J. Conant, Layne & Bowler, Inc., Memphis, Tenn.

The subject of well construction was presented in a paper on "Construction and Maintenance of Deep Wells in Sand Strata," by W. G. Lanham, of the Memphis, Tenn., Water Department and Thomas H. Allen, Consulting Engineer, Memphis.

Discussion of this paper by D. W. Lane, Assistant Engineer, Department of Water & Power, Los Angeles, Calif., was read by J. E. Gibson.

Messrs. F. H. Cunningham and Wellington Donaldson, Engineers of Fuller & McClintock, Consulting Engineers of New York, presented a joint paper on "Memphis Water Supply."

Mr. Charles G. Richardson of the Builders Iron Foundry, Providence, R. I., presented an interesting paper on new developments in metering and control equipment.

The paper was discussed by H. B. Smith of the Simplex Valve & Meter Company, Philadelphia.

Tuesday Afternoon Session. The need for a central committee to collect data on price changes in various sections of the country was brought out by William W. Brush, Chief Engineer, Department of Water Supply, New York City, in his paper on "Changes in Cost of Water Works Labor and Materials."

Major W. A. Hardenberg, Associate Editor of Public Works, New York, presented some interesting figures on water main construction costs for the years 1925, 1929, 1931 and 1932.

In the absence of George W. Booth, Robert C. Dennett, Engineer of the National Board of Fire Underwriters, presented Mr. Booth's paper on "Influence of Water Works on Fire Protection Classifications."

In discussing Mr. Booth's paper, Malcolm Pirnie stressed the importance of developing water works along other lines than for fire protection and called attention to the extension in the human life span in the last twenty years.

Mr. Brush expressed a belief that the fire insurance interest should be more explicit as to what credits would be allowed for specified water works improvements.

Mr. Robert E. Horton, Consulting Hydraulic Engineer, Voorheesville, N. Y., forwarded a very comprehensive paper on Interstate Water Rights which was reviewed by Abel Wolman. It was discussed by N. B. Jacobs, Vice-President of Morris Knowles, Inc., Pittsburgh, who held that the "Golden Rule," was the foundation of practically all decisions relating to diversion of water.

"Recent Developments in Lining for Cast Iron Pipe and Their Application," was discussed in a paper on that subject by D. B. Stokes, Vice-President and H. G. Reddick, Engineer, U. S. Pipe and Foundry Company, Burlington, N. J. The paper was discussed by

E. D. Killam, A. U. Sanderson, George E. Boyd, Wm. W. Brush and others.

Wednesday Morning Session. The first paper was "Expansion of the Los Angeles Distribution System," by W. W. Hurlbut, Water Distribution Engineer, Department of Water and Power, Los Angeles, Cal. In Mr. Hurlbut's absence, Mr. Morris, of Pasadena, presented it. It was discussed by T. J. Skinker, L. B. Howson and others.

Mr. Alfred E. Skinner, Western Manager of the Pitometer Company, Chicago, Ill., presented a paper on cause of waste in distribution systems.

Underground waste detection as a factor in the New York conservation program was outlined in a paper by Fred B. Nelson, Engineer, Department of Water, Gas and Electricity, New York City.

Messrs. H. S. Morse, T. J. Skinker, J. E. Gibson, E. O. Sweet, Wm. W. Brush, L. H. Enslow and others, discussed this paper.

Mr. William C. Mabee, Chief Engineer, Indianapolis Water Co., Indianapolis, Ind., treated the subject of breaks in cast iron pipe gridiron systems and outlined the causes and remedies.

In discussing Mr. Mabee's paper, Thos. F. Wolfe, Research Engineer, Cast Iron Pipe Research Association, offered an effective defense for breaks which may occur in cast iron pipe lines. It was further discussed by T. H. Wiggin and J. E. Gibson.

Wednesday Afternoon Session. The Wednesday afternoon program was in the form of a Superintendents' Round Table discussion. The first paper presented dealt with experience with cement lined cast iron pipe. The discussion was led by E. O. Sweet.

"Government Documents Useful to Water Superintendents and Where They May be Obtained," was the subject discussed by A. F. Porzelius.

A plan of using tags for recording information when taking account of material on hand, was described by C. J. Alfke, Comptroller, Hackensack Water Company, Weehawken, N. J., in his paper, "Inventory Methods for Yard Stocks."

Mr. J. S. Dunwoody, Superintendent Water Department, Erie Pa., outlined the steps taken at Erie, Pa., to take care of emergencies which may arise in the maintenance of the Water Department. The topic was further discussed by W. C. Mabee, T. J. Skinker, L. N. Thompson, and others.

Mr. O. Z. Tyler discussed plant beautification and outlined the

steps taken at Jacksonville to make the water works attractive to the public.

W. S. Patton and A. U. Sanderson made further comments.

Mr. W. S. Patton outlined the methods followed in Ashland, Ky., in locating leaks, and described the equipment employed. Mr. Porzelius emphasized the importance of mapping out the system in connection with a leak survey, and locating underground structures.

H. F. Blomquist, Superintendent, Cedar Rapids, Ia., presented a paper on "How Often Should Water Meters be Tested?"

W. C. Hawley, Chief Engineer and General Superintendent, Pennsylvania Water Company, Wilkesburg, Pa., stressed the importance of the question of small flows used in gas refrigerators, and also pointed out the similarity of the problem incidental to air conditioning apparatus which is now coming on the market.

Mr. Patton called attention to the new Ford Gulper which is designed to measure minute flows. Patrick Gear, of Holyoke, reported an actual test to determine the amount of water flowing through gas refrigerators. The water was collected in buckets and subsequently measured. As a result, a charge of \$3 per year is made for service to gas refrigerators.

Mr. Birkinbine, of Philadelphia, described results of a test in tapping steel pipe and inserting corporation cocks.

At the conclusion of this session, election was held for Chairman of this Division for next year's Convention and H. F. Blomquist, Superintendent, City Water Works, Cedar Rapids, Iowa, was unanimously selected.

Thursday Morning Session. The Committee on Control of Tastes and Odors, of which Martin E. Flentje, Superintendent of Purification, Supervising Engineers, is Chairman, presented a report on the present status of the problem. It was discussed by J. R. Baylis, H. H. Gerstein and F. E. Stuart.

Chairman Ross Dobbin read a resolution presented by S. B. Morris urging upon Congress that no curtailment be made in the work of the U. S. Geological Survey. State legislation was also urged in the resolution to provide for continuance of such work. The resolution was carried unanimously.

Mr. H. E. Jordan, Sanitary Engineer, Indianapolis, Ind., offered a resolution urging upon Congress the passage of a bill now before that body appropriating \$3,000,000 for public health and sanitation work. This resolution also carried unanimously.

Cross Connections with Public Water Supplies was discussed by Samuel B. Morris, Chief Engineer, Water Department, Pasadena, Cal.

In discussing Mr. Morris' paper, Arthur E. Gorman, Engineer of Filtration, Bureau of Engineering, Chicago, Ill., referred to the value of check valves as emphasized by Joel I. Connolly in a paper which he presented before the Association's convention in St. Louis two years ago. John Winder, Chief Engineer, Water Works and Sewerage, Dallas, Texas, described a number of cross connections which had been located and removed at Dallas. E. Sherman Chase, in discussing Mr. Gorman's paper, stated that Committee Number 8 on Cross Connections had completed its work and would soon issue a report. L. S. Finch, Chief Engineer, Department of Sanitary Engineering, Indianapolis, Ind., described an instance where sewage was siphoned into the water works system at the Indiana Girls School through a sudden vacuum being created in the piping connected to the water system.

The Use of Iron and Lime in the Removal of Manganese was described by Malcolm Pirnie, Consulting Engineer, New York. This subject was discussed by Paul W. Frisk, Linn Enslow, and Robert Spurr Weston.

"Unsuspected, Unusual and Little Known Factors in Water Supply Quality" was the title of a paper read by Paul Hansen, Consulting Engineer, Pearse, Greeley & Hansen, of Chicago, Ill.

The Finance and Accounting Division met on this afternoon and the following papers were presented:

"Effect of Meterization on Revenues." By D. C. Morrow. Discussed by E. A. Johnson and F. R. Berry.

"Effect of Proper Sizes of Meters on Revenues." By L. D. Gayton. Discussed by G. D. Kennedy.

"Guaranty Payment of Water Bills." By Jacob Schwartz. Discussed by J. A. Jensen.

"Material Control Policies." By C. J. Alfke. Discussed by Hal Smith.

Thursday Afternoon Session. The first paper at this session was presented on "Relief from Downward Trend in Water Revenues," by E. E. Bankson, of J. N. Chester Engineers, Pittsburgh, Pa.

Mr. Myron B. Reynolds, Assistant City Engineer, Chicago, commented on the results of sales promotion efforts. He said this method of increasing revenue was not applicable in Chicago where meterage

is not complete. He believes that the depression will be the "ill wind" in that it will result in reduction of waste in water systems. He suggested that in time of depression it might be a good move to send out bills once a month, to insure punctual payment. J. A. Jensen suggested checking up on meters to eliminate under-registration. Modification in methods of operation, he believed, might save some of the expense of operating water plants, and a charge for water supplied to the city for municipal purposes should also be made. C. H. Grinnell stated his city is considering billing monthly to tally with the electric light and telephone bills. He believes that the psychological effect would be good, and that it would result in punctual payment of water bills.

The paper "Budgetary Control of Expenses" by E. C. Schwier, Auditor, Indianapolis Water Company, was read by Mr. Mabee.

In opening the discussion of Mr. Schwier's paper, W. C. Mabee, Chief Engineer, Indianapolis Water Company, said that the first year's operation under the control system was far from a success.

In the absence of Mr. V. Bernard Siems, of Siems & Woodbury, New York, N. Y., his paper on the Leveling of Financial Peaks and Valleys by Use of Improvement Reserves was read by L. D. Blum.

Mr. T. A. Leisen, in discussing Mr. Siems' paper, described the operations of the Omaha Public Utilities Corporation (a municipal corporation) which furnishes water, gas and ice to that city. He stressed the fact that the Omaha Corporation is absolutely independent of politics and is run as a financially independent institution.

Mr. Nathan Jacobs emphasized that municipal plants, well managed, are just as efficient as privately owned and operated utilities.

The final paper was on "Recent Trend in Factors Affecting Rate Base." It was presented by L. R. Howson, Consulting Engineer, Alvord, Burdick & Howson, La Grange, Ill. This paper was discussed by G. D. Kennedy, S. B. Morse, and others.

THE WATER PURIFICATION DIVISION

The first meeting opened at about 2 P.M., on Monday, May 2, with the Chairman of the division, Paul Hansen, in charge.

Fred. O. Tonney and Ralph E. Noble of the Section of Technical Service and Research, Chicago Board of Health, prepared a paper on "Colon-Aerogenes Types of Bacteria as Criteria of Fecal Pollution of Water."

This paper was discussed by Frank E. Hale, Director of Labora-

tories, of the New York Water Department and Thomas R. Lathrop, Assistant Sanitary Engineer, Ohio State Department of Health.

A paper by Ralph E. Tarbett, U. S. Public Health Service, Washington, D. C., on "Conformity of Public Water Supplies to U. S. Treasury Standards" was read.

E. Sherman Chase, of Metcalf and Eddy, Boston, presented a paper on "Numerical Rating of Public Water Supplies from the Public Health Standpoint."

Among those who discussed this paper were Robert Spurr Weston, Charles H. Spaulding and William J. Orchard.

A "Progress Report of the Committee on Standard Methods of Water Analysis," was presented by Prof. Jack J. Hinman, Jr., its Chairman. Included in the report were the investigations on an extensive scale by N. J. Howard, Director of Water Purification, Island Filtration Laboratories, Toronto, Can.

John R. Baylis, Chairman, made the "Report of the Committee on Filter Media." The object of the committee is the study of material in use in filter beds. It has worked with a committee of the A. S. C. E. in research along these lines. The A. W. W. A. committee has work underway in Detroit, Chicago and Harvard University. The report was discussed by Oliver J. Ripple and Winfield S. Mahlie.

Practices employed for the removal of manganese in a domestic supply were outlined by Perkins Boynton, Chemist in Charge of Filtration Plant, Clarksbury, W. Va., and Lewis V. Carpenter, Professor of Sanitary Engineering, West Virginia University, in their paper, "Manganese and its Relation to Filters." Robert Spurr Weston and Arthur F. Mellen were among those who discussed this paper.

Charles H. Spaulding, Chemist and Superintendent of Water Purification, Springfield, Ill., presented a paper on "Filter Problems in Connection with Water Softening."

The paper was discussed by Lloyd C. Billings and Daniel H. Rupp.

Experiments conducted at the Baldwin Filtration Plant of Cleveland, Ohio, were described by W. C. Lawrence, Superintendent of Filtration, in his paper, "Further Experience With High Rate of Filter Wash."

A paper on "Water Softening by Zeolite as Used in Municipalities," was presented by S. B. Applebaum, Vice-President, The Permutit Company, New York City. It was discussed by A. S. Behrman.

George R. Spaulding, Assistant Superintendent of Filtration and

Sanitation, Hackensack Water Company, gave some interesting "Experiences with the Use of Powdered Activated Carbon" in his paper on this subject. The paper was discussed by Howard E. Moses, James E. Karlslake, William H. Lovejoy and Alfred Eckert.

Dr. Frank E. Hale, Director of Laboratories, Department of Water Supply, Gas and Electricity, New York City, presented a detailed paper on the "Present Status of Aeration."

Others who spoke in favor of the employment of aeration were William H. Lovejoy, N. J. Howard and James F. Bartuska.

A paper on "Floc Formation and Mixing Basin Practice," was presented by G. E. Willcomb, Sanitary Engineer, Albany, N. Y.

Several suggestions in the use of mixing basins were made by members present, among these being R. Gordon Yaxley, M. C. Smith, and George B. Prindle.

Arthur B. Morrill, Assistant Engineer of Filtration, Detroit Department of Water Supply, prepared a paper on "Sedimentation Basin Research and Design."

ABSTRACTS OF WATER WORKS LITERATURE¹

FRANK HANNAN

The Water Supply of the Communes of Boxtel, Esch, Haaren and Oisterwijk. J. L. ROBORGH. *Water en Gas*, 153, August 22, 1930. *Water and Water Eng.*, 32: 383, 544, November 20, 1930. Water is supplied as per contract from Bois-le-Duc, the economy of distribution being undertaken by the communes of Boxtel and Oisterwijk, each of these having a water tower of the same design. A clear water covered reservoir at Boxtel of 400 cu. m. capacity is divided by a wall to allow alternate working in case of repairs. An adjacent pump station in reinforced concrete contains two electric direct-driven centrifugal pumps of 65 cu. m. per hour capacity at a head of 52 m. which, by automatic control, keep the water towers filled.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

Wallasey Municipal Washhouse and Slipper Baths. Surveyor, 79: 2044, 377, March 27, 1931. A public bath provided to meet the need for bathing and washing facilities in an area where about 6000 homes are entirely lacking in these conveniences. The washhouse, 73 by 45 feet in plan, has internal walls faced with white glazed tile to a height of 11 feet, and is equipped with 16 electrically driven washing machines and an equal number of white glazed fire clay sinks and wood scrubbing boards, six centrifugal drying machines, together with drying horses, heaters, extractors, etc. The mangling and ironing room is equipped with three mangles and five electric hand irons. The bath building has 16 slipper baths and two foam baths for treatment of rheumatism and similar complaints, with necessary accessories. Hours of opening and closing, together with rates of charges for the various facilities, are given.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

A New Collegiate Swimming Pool. *Canadian Engineer*, 59: 6, 209, August 5, 1930. A brief, illustrated description of the new swimming pool at Kennedy Collegiate, Windsor, Ontario. The interior dimensions of the pool are 60 feet by 30 feet, the depth varying from 3 feet 3 inches to 9 feet 6 inches. The pool is provided with two water inlets at each end, located 12 inches below the water line. The discharge outlet is located at the deep point in the pool. The water withdrawn from the pool is treated with alum, filtered, heated, chlorinated and returned to the pool.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

¹Vacancies on the abstracting staff occur from time to time. Members desirous of coöperating in this work are earnestly requested to communicate with the chief abstractor, Frank Hannan, 285 Willow Avenue, Toronto 8. Ontario, Canada.

Public Baths in Oslo for Health's Sake. *American City*, 44: 2, 141, February, 1931. Working on the basis that physical cleanliness promotes health, public baths are intensely promoted in Norway. Oslo, a city of 260,000, will have \$3,250,000 invested in public baths upon completion of work now under way. It is estimated 1,500,000 persons will use the baths provided by the city in 1931. Owing to climatic conditions the swimming pool is largely an innovation in Norway but steam and hot room baths are a custom. Receipts from municipal bath establishments cover operating expenses and overhead.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abstracts).*

Open-Air Swimming Pool Construction. *Surveyor*, 79: 2044, 383, March 27, 1931. This article is an extract of a paper by Mr. S. Hutton descriptive of the open-air pool constructed at Exmouth, South Devon, England, by the municipality. The pool is of reinforced concrete, lined with "Snowcrete," 150 feet long and 60 feet wide ranging in depth from 3.5 feet at one end to 7 feet at the other. Promenades, dressing boxes, shower and foot baths, wading pool and other accessories are provided. The pool will be supplied with chlorinated sea-water at the rate of 30,000 gallons per hour.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abstracts).*

An Investigation into the Clogging of the Filter Beds at Topchanchi Water Works during Hot Weather. B. K. MANDEL. *Indian Medical Gazette*, 66: 2, 84, February, 1931. Water from the top level of a lake was used except during dry hot weather when it was necessary to use a valve at lower level. Serious clogging of the filters resulted. The explanation is that at the lower temperature, 70 to 80°F., the increase in vegetable organic matter with a reduction in dissolved oxygen and evolution of carbon dioxide, favor the growth of low forms of vegetable life and the concentration of iron in a soluble state as ferrous bicarbonate. The action of air and light changes the unstable iron into a gelatinous state which is probably the main cause of the clogging.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abstracts).*

Iodine in Baltimore City Water in Relation to Goitre. H. R. BROLL. *Baltimore Health News, Monthly Bulletin*, 106, April, 1931. In the western part of Maryland, goitre is more prevalent than elsewhere in the State due, it is believed, to the low iodine content of the drinking water; for instance, in Cumberland 0.06 part per billion, while Baltimore in the eastern part has 5.0 parts per billion except in summer. Other contributing factors to this prevalence of goitre is held to be the lack of iodine in the soil, and the failure to include seafood, which is usually abundant in iodine content, in the diet. It is recommended, therefore, that during summer months when the iodine content of the Baltimore water supply is below 0.3 parts per billion that the iodine deficiency be supplemented by the eating of sea foods.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abstracts).*

Value of Regular Systematic Examination of Water. J. M. BEATTIE. *Surveyor*, 78: 2008, 69, July 18, 1930. Since November, 1897, the water of Liverpool has been examined daily for the presence of bacteria. Samples from the

storage reservoirs and the deep wells are secured monthly. The primary object of this examination is the detection of fecal contamination. A secondary object is to provide a means of indicating the amount of organic matter present. Irregular or occasional bacteriological examinations of water supplies are frequently of little value. This is especially true when little or no information is submitted with a sample, concerning the method of collection, temperature and source. This emphasizes the necessity for close co-operation between the water engineer and the bacteriologist. Systematic examination often reveals defects which otherwise would go unnoticed. Two such cases are described. In one case, high *B. coli* counts were found to be due to a small piece of leather lodged at the blind end of a standpipe. In the second case, a high *B. coli* count was found in conjunction with a high count of non-lactose fermenters. Investigation revealed a damaged cover on a water tank which permitted the access of pigeons.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

Brisbane Water Supply. Surveyor, 78: 2009, 93, July 25, 1930. This article is from an exhaustive report of Mr. W. E. Bush on the future water supply of Brisbane, Queensland. The present population of the city is 320,269 and the average water consumption is about 14 m.g.d. or 45 gallons per capita per day. The present supply is taken from two impounding reservoirs the smaller one on Brisbane River (543 million gallons capacity) and the larger one Cabbage Tree Creek (7,000 million gallons capacity). The works recommended include the construction of a dam 293 feet high on the Stanley River which would create a reservoir of 27,000 million gallons capacity and supply 40 m.g.d. sufficient until 1954. The program also includes the construction of a new pumping station, a sedimentation basin and the conversion of existing filter beds into rapid gravity filters. The initial stage of the construction was estimated to cost £1,641,500 and the full ultimate development £5,753,700.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

The Metropolitan Water Board. Water and Water Eng., 32: 384, 552, December 20, 1930. In the twenty-seventh annual report of the Metropolitan Water Board there appear some figures which are of general interest in that they indicate the immensity of the problem of supplying water to London. One hundred seventy-eight slow sand filter beds containing almost 175 acres filter the water. In addition, there are 51 primary filters. Ninety-three service reservoirs having a capacity of 322 million gallons, only two of which are uncovered, serve as storage basins. There are 275 engines with a total horsepower of almost 49,000 pumping the water. The population of about 7.5 million is supplied with water and the rate of consumption is 36.4 gallons per person per day.—A. W. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

Lead Poisoning from Chipping on the U. S. S. "Arizona." I. L. NORMAN. U. S. Naval Medical Bulletin, 29: 2, 337, April, 1931. The author gives a brief summary of some of the literature on the various avenues of absorption of lead dust, especially with reference to absorption through the mucous membranes of the nasopharynx. The paper is followed by bibliography.—A. E. Blohm (*Courtesy U. S. P. H. Eng. Abstracts*).

Detection of Sulfite Waste Liquor in Sea Water. H. K. BENSON and W. R. BENSON. *Ind. Eng. Chem., Anal. Ed.*, 4: 220-3, 1932. Comparison of the bio-chemical oxygen demand of dilute concentrations of sulfite waste in sea water with that of natural sea water for same locality will furnish useful indications. Titration with 0.01 N acid to constant pH outside buffering range of sea water is also helpful; as also are accurate pH determinations. For high concentrations of waste regular analytical data must be obtained.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Dissolved Oxygen in Presence of Organic Matter, Hypochlorites, and Sulfite Wastes. EMERY J. THERIAULT and PAUL D. McNAMEE. *Ind. Eng. Chem., Anal. Ed.*, 4: 59-64, 1932. New modifications of WINKLER method for determination of dissolved oxygen in presence of large amounts of organic material, or of sulfite wastes, have been developed. Careful studies were made of many suggested modifications and sources of error brought to light. Alkaline solution used to precipitate manganese hydrated oxides may readily produce false results by reacting either with high concentrations of organic materials, or with thionate compounds. Method presented for sulfite waste consists in preliminary treatment with alkaline solution of hypochlorite, followed by acidification in presence of iodide and reduction of liberated iodine with sodium sulfite, after which manganese sulfate and alkaline iodide solutions are added as usual, with final titration of liberated iodine with thiosulfate. Comparable analytical tables and complete details are given in this invaluable paper.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Determination of Phosphates in Waters. JASON E. FARRER and GUY E. YOUNGBURG. *Ind. Eng. Chem., Anal. Ed.*, 4: 107-9, 1932. New colorimetric method depending upon formation of blue color with molybdenum. Acid solution is used, in which silica does not interfere. Ferrous iron does not interfere, but ferric iron above 6 p.p.m. does. Copper below 30 times the phosphate, or nitrate below 100 p.p.m., does not affect the test, nor does carbonate, or sulfate. Method is described in detail with comparative tables of results showing its value.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Titration of Zinc with Potassium Ferrocyanide. I. M. KOLTHOFF and E. A. PEARSON. *Ind. Eng. Chem., Anal. Ed.*, 4: 147-50, 1932. Procedure is given for titration of zinc in acid solution, using either diphenylamine, or diphenylbenzidine, as indicator. It is recommended that excess of ferrocyanide solution be used and back titrated with a known solution of zinc. Ferric iron interferes, but can be rendered harmless by addition of potassium fluoride and hydrofluoric acid to solution before titrating.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Intermittent Chlorination of Condenser Water. C. S. BORUFF and K. E. STOLL. *Ind. Eng. Chem.*, 24: 4, 398-400, April, 1932. Slime deposits of sewage fungus in condenser tubes were removed by this treatment. Chlorine dosage of 1.9 p.p.m. in winter and of 4.2 p.p.m. in summer, applied for 4-minute period every 90 minutes, maintained tubes free of slime. This dosage was

applied from solution made by passing chlorine gas into water containing limestone. No indication of corrosion of tubes by this treatment has been noted.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Zinc in Water Supplies. EDWARD BARTOW and OTIS MELVIN WEIGLE. *Ind. Eng. Chem.*, 24; 4, 463-5, April, 1932. Limits of permissible zinc in drinking water were investigated by feeding waters containing varying amounts of the metal to rats. Up to 50 p.p.m. of zinc sulfate produced no harmful effects over period of several weeks. This work indicates that pure zinc salts in normal amounts as found in drinking water are not harmful; but because of possible presence of impurities, it seems advisable not to raise present standard of 5 p.p.m. for drinking water.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Total Solids in Natural Brines. GEORGE ZINZALIAN and JAMES R. WITHROW. *Ind. Eng. Chem., Anal. Ed.*, 4: 210-4, 1932. Ignition at 750°C. appears to be the best method for determining total solids in natural brines containing chiefly sodium, calcium, and magnesium chlorides. Certain corrections must be made in accordance with formula presented in the article.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Coli-Aërogenes Differentiation in Water Analysis. C. C. RUCHOFT, J. G. KALLAS, BEN CHINN and E. W. COULTER. *Jour. Bact.*, 22: 125-81, 1931. It has been previously demonstrated that if mixed cultures of *B. coli* and *B. aërogenes* are present in a water, either organism may outgrow the other in standard lactose broth, when used for the presumptive test. It is impossible to predict which organism may predominate. LEVINE's eosin-methylene-blue-agar, or SKINNER and MURRAY's modification of it, will give the best isolation for this group. A streaked isolation plate may show pure cultural characteristics when mixed cultures are present, due to contamination. These conditions make identification of atypical colonies difficult, even when isolated and checked by GRAM stained smears. Combination of the indol, methyl-red, Voges-Proskauer, and KOSER citrate tests appears to be reliable. The methyl-red and Voges-Proskauer tests are indicative only when pure cultures have been obtained, but the indol and citrate tests are always conclusive, even when the organisms giving these reactions are in small concentrations. This study indicates that the routine isolation of pure cultures from water samples, as at present conducted, after preliminary enrichment in broth, is an unsatisfactory procedure. It is suggested that these four tests be applied to cultures obtained by direct plating of sample into some solid medium. It is thought that such a separation should be developed and included in "Standard Methods."—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Relative Concentration of Negative Ions in Different Parts of an Electro-osmose Apparatus. EDWARD BARTOW and FLOYD W. PERISHO. *Ind. Eng. Chem.*, 23: 1305-9, 1931. Apparatus tested will remove chloride, carbonate, and sulfate ions when operated at rates below 30 liters per hour from solutions containing 250 p.p.m. of these salts. Bicarbonate ions will also be removed at rates below 25 liters per hour when the other ions are present. Waters con-

taining chloride ions in excess of 500 p.p.m. cannot be easily purified. Apparatus has commercial possibilities for small installations.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Parallel Scale Chart. R. C. STRATTON, J. B. FICKLEY and W. A. HOUGH. *Ind. Eng. Chem.*, 24: 180-1, 1932. Diagram for use in estimating dosage for boiler feed water treatment.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Solid Matter in Boiler Water Foaming. C. W. FOULK and V. L. HANSLEY. *Ind. Eng. Chem.*, 24: 277-81, 1932. First paper of an investigation into basic cause of boiler foaming. It is shown that different types of solid material produce various degrees of foaming. Adsorbed oil was considered controlling factor in stabilizing foam produced by boiler scale. Results so far obtained do not justify any general statement as to effect of suspended solids on foaming and priming of boiler waters.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Determination of Boron in Waters. FRED J. FOOTE. *Ind. Eng. Chem. (Anal. Ed.)*, 4: 39-42, 1932. Method, developed to estimate boron in irrigation waters and soils, is accurate to less than 1 p.p.m. Complete description of procedure is given. Tables of comparative results are presented which show it to be reliable.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Elimination of Corrections for Nitrites in Nitrate Determinations. G. H. NELSON. MAX LEVINE and J. H. BUCHANAN. *Ind. Eng. Chem. (Anal. Ed.)*, 4: 56-8, 1932. Nitrite can be removed from acid or faintly alkaline solution by evaporation in presence of ammonium chloride, or sulfate, thus eliminating usual correction for this salt necessary in nitrate determinations. Detailed procedure is given.—*Edw. S. Hopkins (Courtesy Chem. Abst.)*.

Corrosive Well Water. T. A. JONES. *Water Works Eng.*, 85: 4, 193, February 24, 1932. New well supply for Fort Valley, Ga., contained 45 p.p.m. free carbon dioxide and 1.4 p.p.m. iron and had pH value of 5.2. Experimental plant demonstrated that filtration was unnecessary. Plant consisting of a sedimentation basin, mixing flume, decarbonator, dry-feed room, aerator, and chlorination equipment, which eliminated iron and carbon dioxide and raised pH value to 8.4, was built by day labor from earnings.—*Lewis V. Carpenter*.

Silver Changes Water to Bactericide. ANON. *Water Works Eng.*, 85: 4, 196, February 24, 1932. Filter made by adding chloride of silver to molding clay and baking to 2200 F. has power to destroy living bacteria. Water is alleged not to contain any silver. Bactericidal power of water that has passed through silvered filter is claimed to be due entirely to ionization: it disappears if water is boiled for a few minutes.—*Lewis V. Carpenter*.

Elimination of Typhoid. EDWARD D. RICH. *Water Works Eng.*, 85: 4, 197, February 24, 1932. During past twenty years, typhoid death rate in Michigan has been reduced from 60 to 1.8 per 100,000. Detroit rate has been

reduced from 21 to 1. Ford, which takes its supply from the Detroit River (which contains the sewage from Detroit), had maximum rate of 850 and minimum, in 1921, of 64. About this time village of Ford became part of city of Wyandotte, which also took its supply from the Detroit River, but filtered and chlorinated the water. Typhoid rate has been reduced to practically nothing. Graphs show the reduction of typhoid in state of Michigan and in several individual cities.—*Lewis V. Carpenter.*

Stream Pollution by Coal Mine Wastes. R. D. LEITCH. *Water Works Eng.*, 85: 4, 202, February 24, 1932. When acidity of drainage is high, softening will not end the problem; foaming and priming in boilers will result. Neutralization is not the solution, even if financially and mechanically practicable. Accepted theory of acid formation is by atmospheric oxidation of pyrite to readily soluble iron sulfates, which, on further oxidation yield by hydrolysis varying amounts of ferric oxide and free sulfuric acid. Old worked out sections are, invariably, sources of most acid water. Outside gob piles are believed to be important contributing factor in general problem. Rock dusting seems to have merit, but its value has not yet been fully worked out. Most fruitful results so far have been from sealing of mines. Accepted theory of acid formation requires oxygen, pyrite, and water to be present. If one of these is absent, it should naturally follow that acid will not be formed. Tests on some mines in Indiana bear out this hypothesis. Laboratory tests made by passing various gases over iron sulfide show greater development of acidity with moist air than with inert gases. All of work done points to fact that exclusion of air will prevent formation of acid.—*Lewis V. Carpenter.*

Control of Purification. CHAS. R. COX. *Water Works Eng.*, 85: 5, 246, March 9, 1932. Turbidity of coagulated and settled water should be less than 10 p.p.m., or filters will be overloaded. When turbidity of filtered water is less than 0.5 p.p.m., bacterial removal will be satisfactory. Use of Baylis Turbidimeter will give prompt indication as to effectiveness of filtration. Flocc in filtered water is indication either of after-precipitation, or of inefficient sand beds. Beds should be examined for cracks and for evidence of shrinkage. Presence of algae leads to short filter runs and to formation of cracks and mud balls. Wash rate of 24 inches vertical rise per minute is sufficient for adequate washing only when water is cold; control by sand expansion is advocated with 50 percent expansion the preferred rate.—*Lewis V. Carpenter.*

Spend \$10 and Save \$59. ROSS A. THUMA. *Water Works Eng.*, 85: 5, 253, March 9, 1932. Supply with hardness of 150 to 200 p.p.m. may be softened by lime-soda process, at a cost slightly in excess of cost of coagulation, and is more highly purified. Data from experimental plant in Minneapolis show that average cost of softening would be \$10.09 per m.g. where, assuming that 5% of water is used with soap, value of soap saved would amount to \$1.18 per 1000 gallons. Besides the great reduction in calcium and magnesium contents, softening also gets rid of a large amount of color. The ideal boiler-feed water must neither deposit scale, nor corrode. It was estimated that from water containing 13 grains per gallon of scale loss due to excess fuel consumed and

other troubles amounted to 7 cents a pound per 1000 gallons for amount of scale present. These figures have since been revised upwards to 13 cents per pound. Detailed cost estimates show that by spending \$10.09 for chemicals, soap to value of \$59 will be saved.—*Lewis V. Carpenter.*

Fundamentals of Water Softening. A. M. BUSWELL. *Water Works Eng.*, 58: 6, 306, March 23, 1932. Hardness in water is due to calcium and magnesium salts. About twice as much lime is required to remove magnesium bicarbonate as would remove an equivalent amount of similar calcium salt. For this reason, special precautions must be taken when part only of the supply is being softened. Boiling changes magnesium bicarbonate to carbonate which, however, does not precipitate out. Temporary hardness and titrated alkalinity are practically the same when the water contains only calcium carbonates. Use of term temporary hardness is undesirable.—*Lewis V. Carpenter.*

Tests for Turbidity. CHARLES R. COX. *Water Works Eng.*, 85: 6, 314, March 23, 1932. Author gives detailed instructions for preparation of turbidity standards and for use of the Candle Turbidimeter, the Baylis Turbidimeter, and the Baylis Floe Detector.—*Lewis V. Carpenter.*

The Modern Trend in Water Treatment and Its Relation to Engineering Design. CHARLES H. SPAULDING. *Bulletin of the Associated State Engineering Societies*, April, 1932, p. 83. One result of long campaign for education of public has been breakdown of prejudice against use of chemicals and rational acceptance of water treatment by chemical methods. Thus we have today not only the alum with which rapid sand filtration began its career, but many other chemicals as well, including ferrous sulphate, chlorinated copperas, ferric chloride, sodium aluminate, lime, soda, chlorine and chlorine compounds, sulphur dioxide and sulphurous compounds, ammonia and ammonium salts, carbon dioxide, zeolites, and activated carbon, to name some of the more important. We are forced to conclude, therefore, that one trend of water treatment is toward a wider use of chemicals. Pre-sedimentation, with use of mechanical thickeners, has reduced amount of chemical required. Studies of mixing and coagulation have resulted in adoption of mechanical agitation rather than baffled mixing chambers. Clarifiers have been found advantageous to shorten period once thought necessary in coagulating basins and to reduce sludge storage capacity to be provided. Better chemical preparation of the water has made possible the speeding up of filtration rates on rapid sand filters. The number of municipal water softening plants has increased materially. Softening by lime treatment is used where non-carbonate hardness is negligible and by lime-soda, or lime-zeolite, method, if non-carbonate hardness is considerable. Carbon filters are being used either for direct absorption of tastes and odors, or in conjunction with superchlorination to promote removal of excess chlorine.—*H. E. Babbitt.*

Pure Water—Its Past, Present, and Future. H. B. WARD. *Proceedings, Illinois Ass'n. Sanitary District Trustees*, May, 1932, p. 16. Recounts history and development of stream pollution in Illinois, with resulting greater diffi-

culties of obtaining pure water supplies. Some relief has been found through organization of sanitary districts, which have removed much polluting material from our streams.—*H. E. Babbitt.*

Recent Developments in Storage Tanks for Liquids and Gases. H. C. BOARDMAN. Bulletin of the Associated State Engineering Societies, April, 1932, p. 30. Strikingly bold advances in design and erection of storage tanks are described. Economic height of all large (over 50,000 barrels) storage tanks is about 40 feet. Welded joints are superseding riveting. Breather roofs and floating roofs are being used to minimize evaporation. Large, field-erected bullets, or blimps (cylinders with hemispherical or ellipsoidal heads), for gas storage are comparatively recent developments. The "Hortonsphere" is a bizarre development, having shape of drop of water on hot stove. An 80,000-bbl. Hortonsphere has been constructed at Longview, Texas. Analyses of stresses are given. Radial cone tank is most recent development in elevated tank field. Full description of elements of radial cone tanks is given. Radial cone tanks of 2,000,000 gallons capacity have been built. Novel post-to-tank connection is being used, posts connecting to downward extensions of the outside butt straps which form parts of joints between shell plates. Ellipsoidal-bottomed tanks put indeterminate load on riser pipe. Radial cone bottom tank puts a definite load on the riser pipe, as it does on the columns. The Chicago Bridge and Iron Works sponsored a "tank beautiful" contest which aroused world-wide interest. Tank which won first prize is good to look at, but costly to build.—*H. E. Babbitt.*

Acid Treatment of Incrusted Water Wells. H. O. WILLIAMS. Johnson National Drillers Journal, April, 1932. Incrustation is any clogging, or stoppage, of a well screen, or water-bearing formation, which is the result of collection of material in and about openings of screen, or voids of water-bearing formation. It is commonly, but improperly, called "corrosion." Incrustation is the accumulation of extraneous material. It may be caused by either of two conditions, or by a combination of both: first, direct, mechanical incrustation, as with organic materials carried in suspension in the water, and second, as result of precipitation of materials carried in solution in the water. It cannot be prevented entirely, but it can be reduced by minimizing the drawdown in well. This can be done in one of three ways, first, by using a large screen; second, by reducing pumping rate; and third, by dividing total load among a larger number of smaller wells. Incrustation can be removed from screens by pulling them and treating with acid at the surface, or by treating screens and water-bearing formation with acid in place. Latter method is usually more satisfactory, but, to be successful, well screen must be constructed of acid-resisting metal; it should be of material which will avoid electrolytic corrosion; there should be knowledge of the character of incrusting material; and wells in immediate vicinity should be shut down during period of treatment.—*H. E. Babbitt.*

Effects of the Drought of 1930. C. R. KNOWLES. Jour. Western Society of Engineers, February, 1932, p. 47. Furnishes sidelights on trials of municipal

and railroad engineers in providing water; on extent and intensity of the drought; on its effect on temperature, stream flow, and ground water supplies. Water supply of virtually all railroads in drought area was seriously affected. Emergency measures were necessitated, and specific cases are described. Hauling of water, a most expensive innovation, was resorted to by many railroads. In some cases an extra tank car, or locomotive tank, was added to the train equipment to permit longer runs. Experience of Illinois Central Railroad is typical. It is described in some detail. There was no suspension of operation because of the drought, but there was some increase in expense of locomotive operation, because of deteriorated quality of the water.—*H. E. Babbitt.*

Water Purification. A Century of Progress. H. P. EDDY. *Civil Engineering*, February, 1932, p. 82. Development of American Water Supply practice during last 100 years has been one of continuous advancement. Early sources of water were naturally good and needed little purification, but with growth and expansion of cities, danger of contamination increased. At same time, difficulties of finding suitable natural water supplies multiplied. Municipalities were forced to treat available supplies, since new ones were not procurable. Resulting changes in water supply practice constitute brilliant chapter in history of American Engineering. Article furnishes some statistics of historical value, both as to the conquest of disease and as to increase in water purification plants.—*H. E. Babbitt.*

Color and Chemical Constituents of Water and Sewage. EUGENE LEMAIRE. *Le Génie Civil*, January 16, 1932, p. 61. Use of surface waters is becoming more general in France, which now feels need of following British and American practices. General prejudices against colored water are discussed; causes of color are pointed out; U. S. Geological Survey method for measuring color is described, as also method for determining turbidity. Treatment of industrial wastes is discussed and regulations governing their disposal into streams, adopted by Le Conseil Supérieur d'Hygiène de France, are given. Commission is now busy revising these somewhat severe regulations. It is felt that self-purification has not been sufficiently relied upon in formulating the regulations. Great difficulties are encountered in fixing standards of quality for potable waters; many French mineral waters would not pass some standards. Temperature, taste, and other qualities are matters of custom and usage and limiting values of certain qualities are tabulated. Bacterial standards must also be fixed and an inspection bureau created to guard the quality of public water supplies.—*H. E. Babbitt.*

Transforming Sewage into Drinking Water at Los Angeles. ANONYM. *Le Génie Civil*, March 19, 1932, p. 291. Rapid growth of population and great need for water are stressed. Sewage testing station at Griffith Park is described. This station has capacity of 800 cubic meters daily and consists of preliminary settling tanks; digestion tanks from which gas is collected; and aeration tank which treats effluent from digestion tank by activated sludge process. Aërated effluent is aërated and clarified. Effluent from settling

tank is super-chlorinated, precipitated with iron, passed through activated carbon filter, and finally through slow sand filter. Effluent from sand filter is clear, colorless, and odorless.—*H. E. Babbitt.*

Advisability of Standardizing Valves and Packing for Water Service Pumps. J. P. HANLEY et al. Amer. Ry. Engr. Assoc. Proc., 33: 292-294, 1932, Bull. 342. Investigation develops lack of desirability of individual specifications for valves and packing for railroad water service pumps and suggests ordering proprietary brands already in the market in accordance with chart included in report.—*R. C. Bardwell.*

Washouts, Water Changes, and Blow-downs of Locomotive Boilers as Influenced by Water Conditions. E. M. GRIME et al. Amer. Ry. Engr. Assoc. Proc., 33: 284-288, 1932, Bull. 342. Critical foaming concentration should be determined by chemical tests for each respective engine district, and blow-down so regulated as to prevent boiler water reaching this concentration.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Application and Comparative Economy and Effectiveness of Various Coagulants Used in Connection with Softening and Clarifying Water for Locomotive Boilers. R. M. STIMMEL et al. Amer. Ry. Engr. Assoc. Proc., 33: 289-292, 1932, Bull. 342. Railroads are using following coagulants; lime, sodium aluminate, alum, and copperas.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Methods and Value of Water Treatment with Respect to Small Plants for Feeding Compounds. Sodium Aluminate, Soda Ash, or other Chemicals, into Boilers, or Roadside Tanks. C. H. KOYL et al. Amer. Ry. Engr. Assoc. Proc., 33: 270-284, 1932, Bull. 342. Complete treatment and removal of scaling salts is recommended generally for waters containing over 8 grains per gallon hardness and, in special cases, for those below this limit. For proportioning interior, or wayside, treatment, six methods are described in detail.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Progress Report Upon the Cause and Extent of Pitting and Corrosion of Locomotive Boiler Tubes and Sheets. J. H. DAVIDSON et al. Amer. Ry. Engr. Assoc. Proc., 33: 268-270, 1932, Bull. 342. Use of water with pH of 10, or more, is recommended; with elimination of dissolved oxygen where practicable.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Salt Specifications. R. C. BARDWELL et al. Amer. Ry. Engr. Assoc. Proc., 33: 266-268, 1932, Bull. 342. Specifications for salt, to be used in regeneration of zeolites for water softening, quote minimum limit for NaCl at 98.0 percent and fineness such that 90 percent shall be between $\frac{1}{16}$ and $\frac{1}{8}$ inch in diameter.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Standard Methods of Water Analysis and Interpretation of Results. R. C. BARDWELL et al. Amer. Ry. Engr. Assoc. Proc., 33: 261-266, 1932, Bull. 342. Rapid methods are outlined for both field and laboratory examination of

water for substances usually affecting boiler operation, together with interpretation of results.—*R. C. Bardwell (Courtesy Chem. Abst.)*.

Texas & Pacific Overhauls Water Supplies. ANON. *Ry. Age.* 92: 15, 596-598, 1932; *Railway Engineering and Maintenance*, 28: 4, 256-260, 1932. On 1200-mile line of Texas & Pacific RR. from New Orleans, La., to El Paso, Texas, annual rainfall varies from 70 inches in Louisiana to 15 inches in west Texas, giving rise to wide variety of water problems. Due to unreliability of many Louisiana bayous, it was necessary to install deep wells at many points. In western Texas, 22 reservoirs were developed, varying in capacity from 21,000,000 to 630,000,000 gallons. At Toyah, Texas, it was necessary to build 37.5-mile pipe line to mountain spring. At 56 of 63 pumping stations, steam units were replaced with oil engines, or motors. Water treatment was provided at 25 stations, using lime, soda ash, and sodium aluminate, and 10 additional sodium aluminate wayside plants are being installed. Additional 37 steel tanks varying in capacity from 50,000 to 300,000 gal. have been installed, making 50 in service. Considerable economy has been effected in pumping costs and boiler conditions have also been greatly improved.—*R. C. Bardwell*.

Deep Well Pumps. GEORGE L. DAVENPORT. *Railway Engineering and Maintenance*, 28: 3, 206-207, 1932. Although there are a few unusual cases where deep-well reciprocating pumps are used for depths of 500 feet, or greater, it is considered better practice to use deep-well turbines for depths less than 200 feet and air lifts for greater depths.—*R. C. Bardwell*.

Water Columns. R. C. BARDWELL, C. R. KNOWLES, and J. R. SOUTHCOTT. *Railway Engineering and Maintenance*, 28: 5, 344, 1932. Dependability, durability, positive action, and flexibility in design, are stressed.—*R. C. Bardwell*.

Keeping "Jack Frost" Out. E. M. GRIME. *Railway Engineering and Maintenance*, 27: 11, 961-963, 1931. Attention is called to importance and multiplicity of details requiring attention by water supply forces on northern railroads in order to prevent train delays due to water shortage during cold weather.—*R. C. Bardwell*.

Use Concrete Tanks in Hot-Water Service. W. C. REICHOW. *Railway Engineering and Maintenance*, 28: 2, 107, 1932. Concrete tanks of about 23,000 gallons capacity with one, or more, coats of asphalt water proofing on inside surfaces are giving good result on Great Northern RR. in hot water boiler washout storage at St. Cloud, Minn., and Great Falls, Mont.—*R. C. Bardwell*.

Automatic Skimmer Gives Oil-Free Effluent. R. L. HOLMES. *Railway Engineering and Maintenance*, 28: 1, 35-36, 1932. To prevent oil waste from causing trouble in sewers, Texas and Pacific RR. have designed concrete separator basin with baffles and with weirs and skimmer openings in the side,

back of the baffle and above the weir over which waste oil flows to retention chamber. Detail plans are shown.—*R. C. Bardwell.*

Winter Tank Operation. E. M. GRIME and E. C. NEVILLE. *Railway Engineering and Maintenance*, 28: 1, 49-50, 1932. Proper installation and maintenance are recommended, to prevent freezing; with heating facilities for infrequently-used water stations.—*R. C. Bardwell.*

Providing Sanitary Facilities for Outlying Points. ANON. *Railway Engineering and Maintenance*, 28: 1, 41-42, 1932. The Southern Pacific Ry. has designed reinforced concrete septic tanks with depressed filter beds, of capacities to serve from 25 to 75 people, for use at outlying points where sanitary facilities are not available. Construction details and method of operation are given, with claim that cleaning and attention are necessary only at 10-year intervals.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Effects of Drought Linger. C. R. KNOWLES. *Railway Engineering and Maintenance*, 27: 12, 1052-1053, 1931. Review of records indicates that 1930 drought was most severe ever experienced in the United States and that its effect upon railroad operation was still being noted in November, 1931.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Dearborn Develops Concentration Hydrometer. ANON. *Railway Engineering and Maintenance*, 28: 5, 345, 1932. *Ry. Age*, 92: 15, 608, 1932. New concentration hydrometer, for determining total dissolved solids in boiler-water, has in-built hydrometer, thermometer, and conversion table for reading concentration direct in terms of grains per U. S. gallon. Concentration range indicated is from zero to 1,200 grains per U. S. gallon.—*R. C. Bardwell (Courtesy Chem. Abst.).*

Nalco Continuous Blow-Down System. ANON. *Ry. Age*, 92: 10, 407, 1932. To permit operation of locomotive boilers for full 30-day legal limit between washouts, continous blow-off system was designed, with piping arrangement for cooling blow-off water in engine tank and with side attachment to centrifugal separator, for taking care of flash and heavy blows.—*R. C. Bardwell (Courtesy Chem. Abst.).*

NEW BOOKS

Report on the Working of the Water Analysis Laboratory (Corporation of Madras) for the Year 1928. S. V. GANAPATI. 24 pp. Owing to increased consumption and adoption of policy of filtering all water supplied, the slow sand filters were operated at rates up to twice the normal of 4 inches vertical per hour [2.6 m.g. per acre per 24 hours]. Applied water, which is chlorinated, was of consistently good bacteriological quality, but filtered water was frequently unsatisfactory. Production of hydrogen sulfide in the filters, accompanied as usual by whitish, gelatinous growths in filtered water chamber and central collecting drains, continued to be troublesome (cf. *THIS J.*, 22: 272). An out-

break of cholera occurred during year. Atypical vibrios (cf. THIS J., 19: 468) are normally present in both Red Hills Lake water and the town supply after superchlorination and filtration. History of the plant, present operating practice, and results of numerous investigations made in connection with the supply are outlined in 3 appendices.—*R. E. Thompson.*

Report on the Working of the Water Analysis Laboratory (Corporation of Madras) for the Year 1929. S. V. GANAPATI. 11 pp. The slow sand filters, which were operated at a constant rate of 6 inches vertical per hour [3.9 m.g. per acre per 24 hours], functioned more uniformly than during previous year (cf. previous abstract) and effluent was of better bacteriological quality, although still inferior to applied (chlorinated) water. Atypical vibrios were persistently present but no outbreak of cholera occurred during year. A government committee has recommended installation of percolating filters operated at rate of 24 inches vertical per hour [15.6 m.g. per acre per 24 hours], and operation of slow sand filters as secondary filters at 8 inches vertical per hour [5.2 m.g. per acre per 24 hours].—*R. E. Thompson.*

back of choice occurred during year. Annual report of the year 1910 is normally present in both Lake Erie and the lower part of the Niagara River. History of the plant, investigation and results of numerous investigations made in connection with the water supply are mentioned in 3 chapters. W. E. Thompson.

Report on the Work of the Water Supply Laboratory, Corporation of the City of New York, 1910. By J. E. Thompson. 11 pp. The report is a summary of the work of the laboratory during the year 1910. It is divided into four parts: (1) General, (2) Water, (3) Sewage, and (4) Other. The first part is a general statement of the work of the laboratory. The second part is a report on the work of the water supply laboratory. The third part is a report on the work of the sewage laboratory. The fourth part is a report on other work of the laboratory. W. E. Thompson.

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NEW YORK

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